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INSTRUCTION MANUAL

MODEL 134
SWEEP GENERATOR

4306

ORATORIES

WAVETEK

9045 BALBOA AVENUE, SAN DIEGO, CALIFORNIA

Serial No. _____

INSTRUCTION MANUAL

MODEL 134
SWEEP GENERATOR

WAVETEK
Box 651, San Diego, Calif., 714-279-2200
Box 1987, Indianapolis, Ind., 317-783-3221

1R-11/69

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NOTE

It is possible to adjust the controls of the Model 134 and Model 135, in the X1M range, beyond the specified limits of the generator—and the instrument will stop oscillating. This condition is easily corrected by turning the frequency VERNIER control in a clockwise direction until oscillation again occurs. This condition is well below 1/1000th of the top of the dial.

It is also possible to stop the generator from oscillating by applying a negative voltage to the VCG summing node when the MODE selector switch is set to TRIG SWP and the SWEEP WIDTH control is set to maximum. If the generator stops oscillating, turn the frequency dial counterclockwise until oscillation again occurs. This condition is also well below 1/1000th of the top of the dial.

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WAVETEK
MODEL 134
SWEEP GENERATOR
FREQ HZ
X 1K
X 10K
X 100
X 100K
X 10
X 1M
PWR OFF
VERNIER
SWEEP
20 V P P MAX
VCG IN
50Ω OUT
TRIG IN
MODE
GATED
CONT SWP
TRIG
TRIG SWP
CONT
TONE BURST
TRIG LEVEL
SWEEP WIDTH
VARIABLE
SWEEP TIME
100mS
10mS
1S
1mS
100S
100µS
OFF
10µS
VARIABLE
SWEEP OUT

SECTION 1
TECHNICAL CHARACTERISTICS

SECTION 1 - TECHNICAL CHARACTERISTICS

SCOPE OF MANUAL

This manual contains instructions for operating, testing, and maintaining the Wavetek Model 134 Sweep Generator. The Wavetek product-improvement program ensures that the latest electronic developments are incorporated into the Wavetek instruments by the addition of circuit and component changes as rapidly as development and testing permit. Due to the time required to document and print these manuals, it is not always possible to incorporate these changes into the manual. In this case, data will be found on engineering change sheets at the back of the manual. If there are no change sheets, the manual is correct as printed.

SCOPE OF EQUIPMENT

The Model 134 is a precision source of sine, square, and triangle waveforms with selectable and variable outputs over a dynamic frequency range of 0.2 Hz to 2 MHz. The instrument also offers frequency control by external voltage for either dc programming or wideband ac FM applications. Additionally, the Model 134 can be operated as a triggered or gated CW generator and as a continuous or triggered sweep generator.

CW Generator Operational Modes

Continuous Frequency Operation provides a fixed-frequency output for the selected frequency, amplitude, and waveform. The output frequency is determined by the FREQ HZ range selector and frequency dial settings. Output amplitude is controlled with the 20 V P-P MAX continously-variable potentiometer, and the waveform is selected by the function selector.

Gated Frequency Operation provides a multicycle output of the selected waveform, frequency, and amplitude when an external signal is applied to the TRIG IN connector. Burst duration is a function of external signal duration.

Trigger Operation provides a one-cycle output of the selected waveform with the application of an external trigger. The external signal may be either ac or stepped dc from +1 volt to +12 volts, applied at the TRIG IN connector. The TRIG LEVEL control is used to establish the threshold bias.

Tone Burst Operation provides internally-generated, recurring bursts of fixed frequencies. Burst duration is adjustable with the TRIG LEVEL control. Frequency, amplitude, and waveform are selected as in continuous frequency operation.

Sweep Generator Operational Modes

Continuous Sweep Operation provides an internally-generated, sweep frequency output of the selected waveform, amplitude, and low-end frequency. Sweep width and sweep time are selected in conjunction with the low-frequency limit established by the setting of the frequency dial and FREQ HZ range selector. The output frequency increases from the lower frequency to the upper frequency, which is established by the setting of the SWEEP WIDTH selector, at the rate set by the SWEEP TIME selector. When the upper frequency is reached, the output frequency returns rapidly to the lower limit and the cycle is repeated.

Trigger Sweep Operation provides a sweep-frequency output at the selected frequency, amplitude, and waveform each time an external signal is applied to the TRIG IN connector. Sweep width and time are selectable as in continuous sweep operation, but the sweep cycle is not repeated until another external trigger arrives.

VCG Generator Operational Mode

Wide Band AC Operation permits frequency modulation of the selected waveform with an external analog voltage not to exceed 5-volts, peak-to-peak. Frequency ratio is adjustable from 100:1 (calibrated) to 1000:1 (uncalibrated) by turning the frequency vernier control.

DC Programming allows changes in either the fixed-frequency output of continuous-frequency operation or the low-limit frequency during continuous sweep operation. This is accomplished by programming a dc voltage into the VCG IN connector of 0 to 5 volts, which is summed with the voltage of the frequency dial and the vernier control to change the output frequency.

FUNCTIONAL DESCRIPTION

Main Generator

The basic generator circuitry (Figure 1-1) consists of the integrator and hysteresis/output switch. The square wave from the output switch is applied to the VCG circuit where

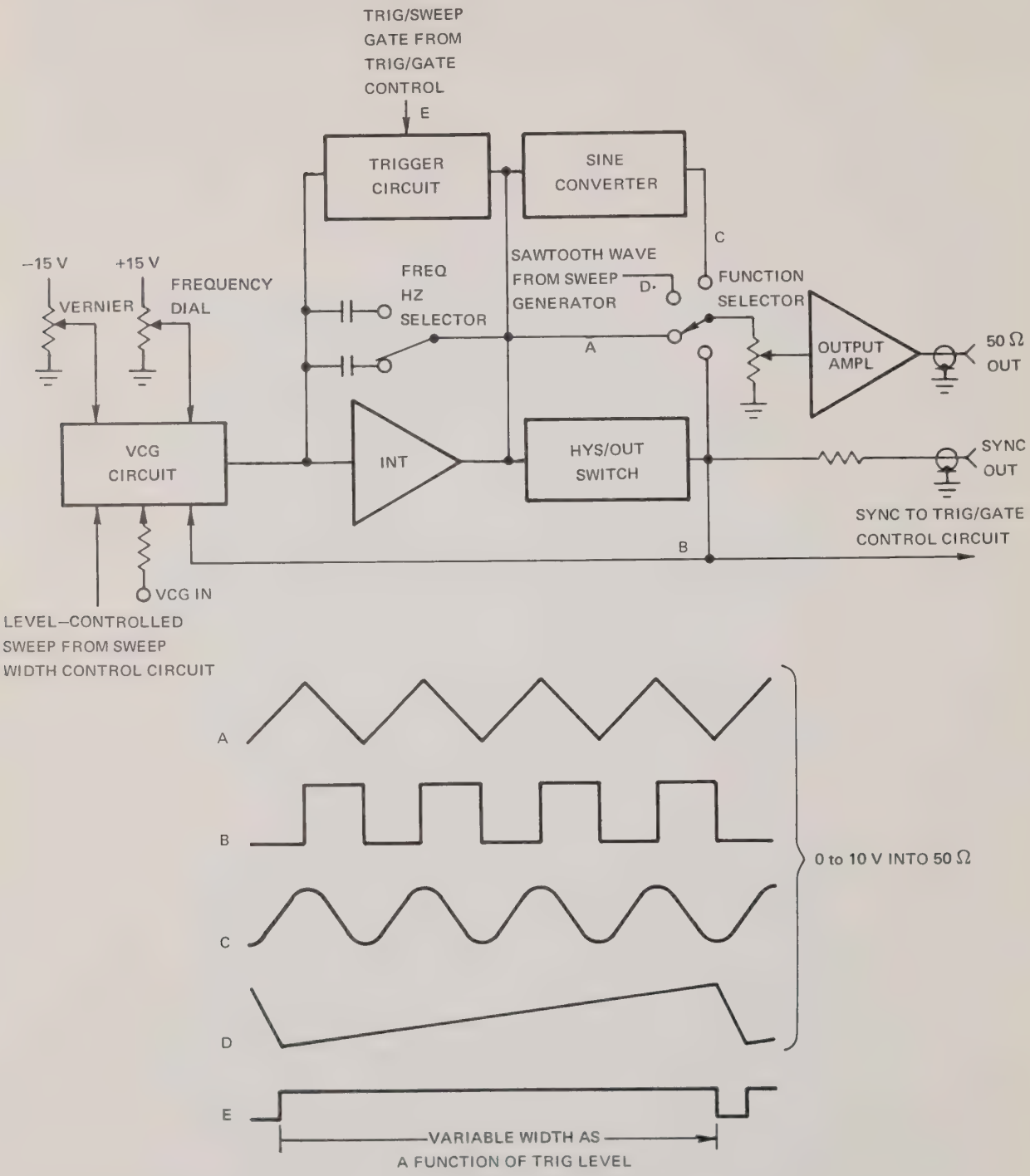


Figure 1-1. Main Generator

it gates a current, which is proportional to the sum of the VCG input, frequency dial, and vernier control voltages, into the integrator summing node. The integrator transforms the square wave into a triangle wave that is applied to the hysteresis switch. The hysteresis/output switch functions similarly to a Schmitt trigger with its limit points set far apart. When a limit point is reached, the hysteresis/output switch fires and reverses the polarity of the square wave into the integrator, causing the triangle wave to also reverse direction. The result is simultaneous generation of square and triangle waves of the same frequency, having the positive portion of the square wave coincident with the negative slope of the triangle.

Oscillation frequency is determined by a timing capacitor selected by the frequency range switch and the integrating current controlled by the frequency/vernier potentiometers. The main generator trigger circuit is disconnected in the continuous-frequency operation just described. When a triggered, gated, or tone-burst operation is selected, this circuit places a shunt path between the integrator input and output. Therefore, there is no output at the 50-ohm BNC until an external trigger/gate signal is applied to the trigger input connector; or, for tone burst mode, an internal gate voltage is generated by the sweep circuitry. A trigger input enables the generator for one complete cycle of the selected waveform. Then the main generator is disabled again until another trigger arrives. A gate input allows the generator to function for the duration of the gate. For tone bursts, the selected waveform appears automatically at the 50-ohm BNC as a gated signal with the gate duration established by the internally-generated sawtooth waveform.

The triangle output of the integrator is transformed into a sine wave by the sine converter circuitry. The triangle, square wave, sine wave, and sawtooth wave are connected to the function selector switch. The selected waveform is amplified by the output amplifier and connected to the 50-ohm BNC. (The sawtooth waveform is described in the *Sweep Generator* discussion.)

Sweep Generator

Figure1-2 presents a functional block diagram of the sweep/gating circuitry to supplement the following discussion. When operating in the continuous frequency, continuous sweep, or triggered sweep mode, the output of the trigger/gate control circuit disconnects the main-generator trigger circuit and the main generator intially produces an output frequency that is a function of the frequency dial setting, frequency-range selector, frequency-vernier control, and VCG input voltage. In triggered-sweep operation, the output frequency begins to increase when a trigger pulse is applied to the trigger input BNC. Rate of change from the low to high limit is a function of the sweep time control settings. This switch connects different values of capacitance into the feedback path of the sweep integrator so that its sawtooth output varies in frequency and produces the selected time interval. The output sawtooth of the sweep generator is connected to the sweep output BNC, to the function selector, and to the sweep width control. This control connects different values of resistors to the VCG input circuit so that the sawtooth input varies in peak current as a function of the selected sweep width. If the frequency controls are set for 2 kHz (X 100 kHz range), sweep time for 1 msec, and sweep width for 2.0, the selected waveform at the 50-ohm BNC will swing from 2 kHz to 200 kHz in 1 msec each time a trigger occurs. Continuous sweep operation with these settings produces a recurring 2 kHz to 200 kHz output at a 1 kHz repetition rate.

The mode switch disconnects the sawtooth from the VCG circuit in the continuous, triggered, gated, and tone-burst modes. Gated operation direct couples the external gating pulse from the trigger input BNC to the trigger/gate control circuit which, in turn, disconnects the main generator trigger circuit for the duration of the external signal. Trigger operation places capacitance between the comparator and control circuit to differentiate the external pulse and momentarily disconnects the trigger circuit, allowing one cycle of the selected frequency to be produced by the main generator.

During tone-burst operation, the sweep generator output is connected to the trigger comparator input. Since the sweep-width control circuit disconnects the sawtooth from the VCG input in this mode, the tone-burst output is a fixed frequency with the burst duration established by the setting of the trigger level control.

The hysteresis/output switch synchronizing pulse applied to the trigger/gate control circuit prevents this circuit from reconnecting the main generator disable before a full cycle is completed.

SPECIFICATIONS

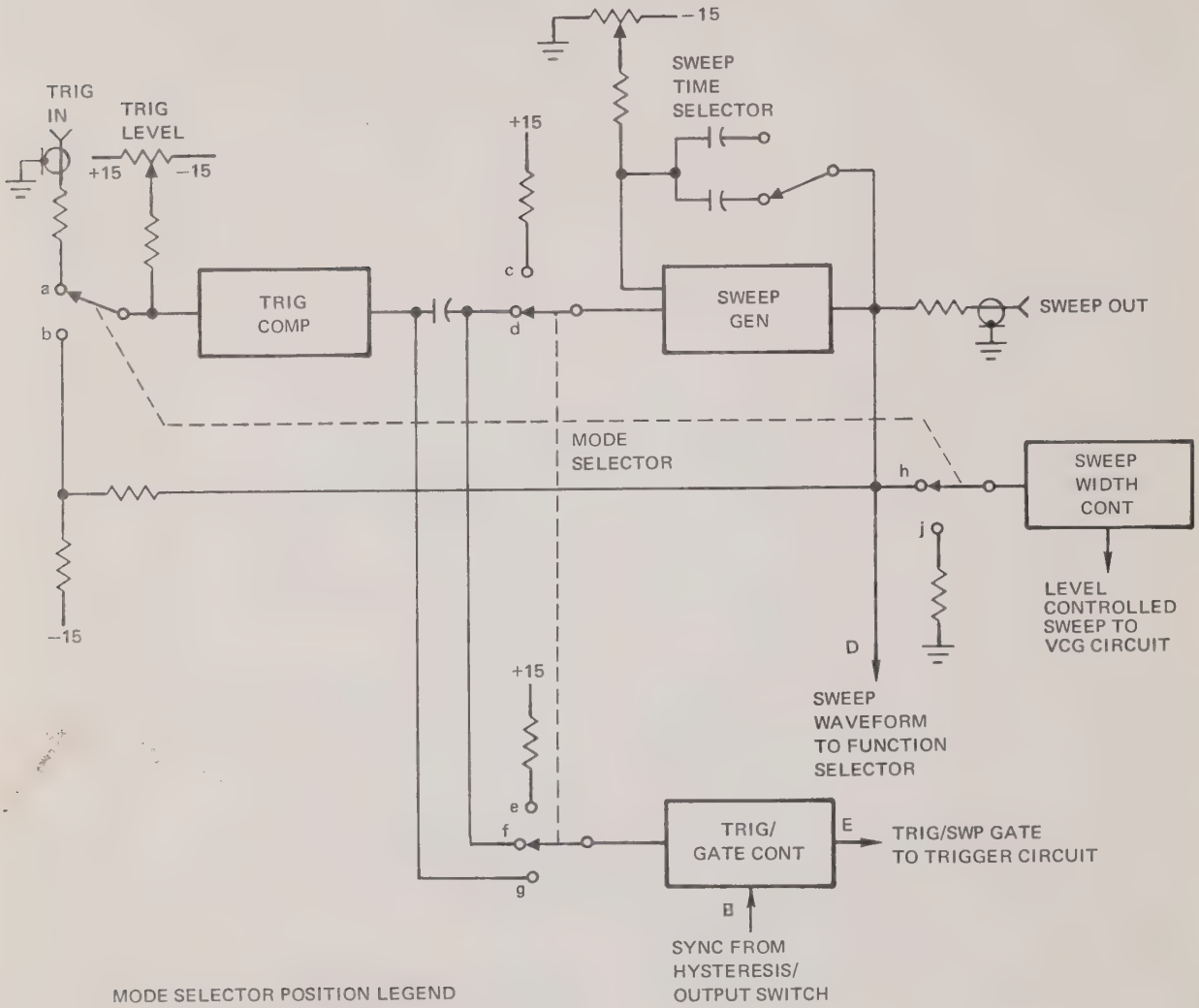
VERSATILITY

Waveforms
Sine ∿ , square ⊓ , triangle △ , and sweep ⟋ .

Dynamic Frequency Range
0.2 Hz to 2 MHz.

Ranges

X10	0.2 Hz to 20 Hz
X100	2 Hz to 200 Hz
X1K	20 Hz to 2 kHz
X10K	200 Hz to 20 kHz
X100K	2 kHz to 200 kHz
X1M	20 kHz to 2 MHz



MODE SELECTOR POSITION LEGEND

a. TRIG, GATED, TRIG SWP
b. TONE BURST
c. CONT, TRIG, GATED, CONT SWP, TONE BURST
d. TRIG SWP
e. CONT, CONT SWP, TRIG SWP
f. TRIG
g. GATE , TONE BURST
h. CONT SWP, TRIG SWP
j. CONT, TRIG, GATED, TONE BURST

Figure 1-2. Sweep Generator

Outputs
Sine ∿ , square ⊓ , triangle △ , and sweep ⟋ , selectable; amplitude variable over 40 db; 50Ω output impedance (600Ω available); 20 V p-p into open circuit and 10 V p-p into 50Ω load from 50Ω source impedance. Separate ramp output at 5 volts peak and 600 ohms impedance.

Sync Output
Greater than 1 V p-p square wave into open circuit at 600Ω output impedance.

DC Offset
±5 V offset (±2.5 V offset into 50Ω load) controlled from rear panel; peak amplitude limited by the dynamic range of the amplifier output.

VCG—Voltage Controlled Generator
Frequency of generator may be dc-programmed or ac-modulated by external 0 to 5 V signal. Voltage control circuitry is capable of 1000:1 deviation. The VCG amplifier has a 100 kHz bandwidth and a slew rate of 0.1 V/μsec. The instantaneous frequency is the result of the sum of the dial setting and the externally applied voltage.

NOTE

It is possible to stop the generator from oscillating by applying a negative voltage when the dial is already set at minimum frequency. Inputs up to 30 V will not permanently damage the instrument, however.

Stability

Short term	±0.05% for 10 minutes
Long term	±0.25% for 24 hours

Percentages apply to amplitude, frequency, and dc offset.

OPERATIONAL MODES

Continuous*
Operates as a standard VCG. Frequency determined by dial/vernier/range settings in parallel with VCG input.

Trigger**
One complete cycle is generated by applying a pulse to the trigger input.

Gated**
Same as trigger except that cycles continue for the duration of input gate.

Continuous Sweep
The main generator is frequency modulated by the sweep generator. When swept, the main generator frequency rises from the frequency set by the dial and range settings to a frequency selected by the sweep-width controls. Sweep rate is set by panel controls.

Trigger Sweep
Same as continuous sweep mode except one complete sweep cycle is generated for each input trigger pulse. Main generator continues to oscillate between sweep cycles.

Tone-Burst
Main generator is gated by the sweep output (internally connected). The tone-burst rate, frequency, and length can be independently controlled.

Trigger Input
1 V peak into 10 kΩ impedance dc coupled to 200 kHz, proportionally greater at higher frequencies.

Sweep Time
10 μsec to 100 sec.

Sweep Width
Up to 1000:1 with calibrated control.

*Both generators free run.
**Sweep generator free runs, main generator is triggered or gated.

HORIZONTAL PRECISION

Dial Accuracy
±2% of full scale 1 Hz to 2 MHz.

Electronic Frequency Vernier
One turn for approximately 1% of full-scale change.

Time Symmetry
±1% through X100K range.

VERTICAL PRECISION

Sine Wave Frequency Response
Amplitude change with frequency less than:
0.1 db from 0.2 Hz to 200 kHz
0.5 db from 0.2 to 2 MHz

PURITY

Sine Wave Distortion
Less than:
0.5% on X10, X100, X1K, X10K ranges
1.0% on X100K range
2.0% on X1M Hz range

Square Wave Rise and Fall Time
Less than 100 nsec.

ENVIRONMENTAL

Temperature
All specifications listed, except stability, are for 25°C ±5°C. For operation from 0°C to 55°C, derate all specifications by factor of 2.

MECHANICAL

Dimensions
8-1/2 inches wide, 5-1/4 inches high, 11-1/2 inches deep.

Weight
8 lb net, 11 lb shipping.

Power
105 V to 125 V or 200 V to 250 V, 50 Hz to 400 Hz. Less than 20 watts.

NOTE

All specifications apply for frequencies obtained when dial is between 0.1 and 2 and at 10 V p-p into a 50Ω load.

SECTION 2
OPERATING INSTRUCTIONS

INSTALLATION

Converting to 230-Volt Line Power

The Model 134 Sweep Generator is shipped from the factory with the power transformer connected for 115-volt line power, unless ordered for 230-volt use. Converting a 115-volt unit for 230-volt operation is a simple matter:

1. Remove power cord.
2. Loosen two captive thumb screws on rear panel and remove panel.
3. The conversion switch is located on the chassis. Use a thin-bladed screwdriver to move the 115-230 switch to the 230 position.
4. Replace 1/4-ampere fuse with a 1/8-ampere fuse of the same type.

Connect Signal and Chassis Grounds

The instrument is shipped from the factory with the signal ground floating above chassis ground, unless otherwise specified. A common signal/chassis ground can be obtained as follows:

1. Remove power cord.
2. Loosen two captive thumb screws on rear panel. Remove panel and cover.
3. Solder a jumper wire between the ground lugs (green wires) of the SYNC OUT connector and the power connector (Figure 2-1).

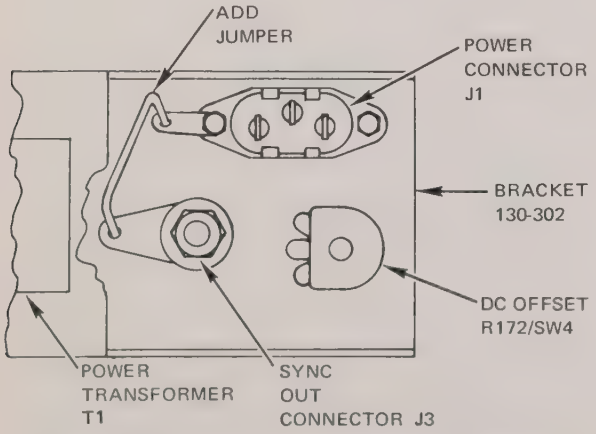


Figure 2-1. Common Ground Connection Diagram

INSPECTION

The following procedures should be performed to assure the user that the instrument has arrived at its destination in proper operating condition. Complete calibration and checkout instructions are provided in Section 4 for determining if the instrument is within electrical specifications.

Checking Visually

After carefully unpacking the instrument, visually inspect the external parts for damage to knobs, dials, indicators, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the instrument. Retain the shipping container and packing material for use in case reshipment is required.

Checking Electrically

NOTE

Refer to *Installation* paragraph for 115-volt or 230-volt line power instructions.

The procedural steps in this paragraph provide a quick checkout of instrument operation. If electrical deficiencies exist, refer to the *Warranty* in the front of this manual. The following test equipment, or equivalent, is recommended for performing this electrical inspection. (Refer to Table 2-1 and Figure 2-2 for operating control descriptions.)

Name	Manufacturer	Model
Oscilloscope	Tektronix	544
Dialamatic Voltmeter	Wavetek	201
Function Generator	Wavetek	110
Counter-Timer	Monsanto	101A

Table 2-1. CONTROLS, INDICATORS, CONNECTORS

Name	Description
FREQ HZ range selector	Selects frequency range from X10 to X1M in increments of 10. Line voltage applied to power supply in any range position. Also has power off position.

Table 2-1. CONTROLS, INDICATORS, CONNECTORS CONT.

Name	Description
Frequency dial	Selects frequency in continuously variable operations from 0.02 to 2.0; dial divisions in increments of 0.05.
VERNIER frequency control	Provides fine tuning with 1% of full-scale range. When frequency dial is set at .02 (1/100 of range) VERNIER controls frequency to approximately .002 (1/1000 of range).
Function selector	Selects sine, triangle, square, or sweep (sawtooth) wave output.
20 V P-P MAX control	Adjusts output level from 100 mV to 10 V p-p (50Ω load).
DC OFFSET potentiometer	Adjusts baseline of output waveform over ±1/2 of full-scale level.
MODE selector	Selects operational mode: continuous, triggered, gated, or tone burst for cw operation; continuous or triggered for sweep operation.
TRIG LEVEL control	Adjusts firing points of generator with external trigger/gate operation, or internal tone-burst operation.
SWEEP WIDTH selector	Selects sweep bandwidth.
VARIABLE control	Fine tuning for sweep bandwidth.
SWEEP TIME	Selects sweep repetition rate.
VARIABLE control	Fine tuning for sweep repetition rate.
Frequency dial index	Illuminated frequency dial alignment point. Illumination also indicates power applied.
50Ω OUT connector	Connects selected output waveform to load.

Table 2-1. CONTROLS, INDICATORS, CONNECTORS CONT.

Name	Description
SYNC OUT connector	Connects output pulse for synchronizing applications.
VCG IN connector	Connects 0 to ±5-volt dc programming or wideband ac input signal to VCG circuit.
TRIG IN connector	Connects external trigger or gate signal into trigger comparator circuit.
SWEEP OUT connector	Connects sawtooth output of sweep generator to external 600-ohm load.

1. Turn FREQ HZ selector to the X1K position. (This connects ac power to the unit and establishes the frequency multiplier.)
2. Connect oscilloscope to the 50Ω OUT connector with 50-ohm terminator.
3. Set frequency dial to the 1.0 mark and MODE selector to CONT.
4. Set function selector to ∿ .
5. Rotate 20 V P-P MAX control to its maximum clockwise position.
6. Check for 1-kHz sine wave with greater than 10 V p-p amplitude on oscilloscope.
7. Select ⩘ and ⎍ with function selector and check for 10 V p-p amplitude on oscilloscope.
8. Turn frequency dial from maximum counterclockwise to maximum clockwise positions and check for frequency change.
9. Rotate 20 V P-P MAX control from maximum clockwise to maximum counterclockwise positions and check for decreasing amplitude.
10. Rotate VERNIER to maximum cw position. Set frequency to 20 Hz with counter. Connect 0 to +5 Vdc input to the VCG IN connector. Slowly increase voltage input from 0 to maximum and check that frequency of output waveform increases approximately from 20 Hz to 2 kHz.
11. Set MODE selector to TRIG. Disconnect power supply from VCG IN connector. Rotate TRIG LEVEL control while observing oscilloscope. One cycle of selected waveform should appear.
12. Set MODE selector to GATED. Rotate TRIG LEVEL control while observing oscilloscope. Waveform should appear at cw position and disappear at ccw position.
13. Set MODE selector to CONT SWP. Set frequency to 20

Figure 2-1. Controls and Indicators

Hz with counter. Set SWEEP WIDTH to 2.0. Set SWEEP TIME to 1S. Displayed frequency should sweep recurringly from 20 Hz to 2 kHz at a 1 Hz rate.

14. Set MODE to TRIG SWP. Rotate TRIG LEVEL control, while observing oscilloscope. Displayed frequency should sweep once from 20 Hz to 2 kHz in 1 second.
15. Set MODE selector to TONE BURST. Rotate TRIG LEVEL control, while observing oscilloscope. Tone bursts at 20 Hz should appear with bursi duration varying with rotation of TRIG LEVEL control.
16. Connect oscilloscope to SWEEP OUT connector. Set MODE selector to CONT. Set SWEEP TIME to 1 mS. Oscilloscope should display a 1 kHz sawtooth.
17. Connect oscilloscope to SYNC OUT connector. Set frequency dial to 2.0. Oscilloscope should display a 2-kHz square wave.

OPERATION

NOTE

One-half hour warmup is required for generator to stabilize at specified accuracies.

Operating as a Function Generator

NOTE

A 50-ohm termination results in 10 V p-p maximum output level. Open-circuit termination gives 20 V p-p. Loads between these limits provide intermediate maximum output levels.

1. Set MODE selector to CONT position.
2. Set function selector for desired waveform.
3. Set FREQ HZ range selector to desired multiplier.
4. Set desired frequency dial mark under illuminated dial.

NOTE

The VERNIER control must be in full cw position for calibrated-frequency operation over the .1 to 2 dial range. If this control is in full ccw position, dial range is uncalibrated, but extended to approximately 1/1000 of full scale.

5. Set 20 V P-P MAX control for desired output level.
6. If triggered/gated operation is desired, inject a 1-volt peak signal into TRIG IN connector with MODE selector in TRIG or GATED position. Trigger operation provides one cycle of the selected waveform for each step-voltage

input. Gated operation produces a tone burst with its duration equal to the duration of the step voltage.

NOTE

A 1-volt peak signal is required for trigger rates up to 200 kHz. Proportionally higher voltage is required for higher frequencies.

Operating as a VCG Generator

1. Set MODE selector to CONT position.
2. Set function selector for desired waveform.
3. Set FREQ HZ range selector to desired multiplier.
4. Connect external voltage source (dc programming or wideband ac signal) to VCG IN connector.

NOTE

VCG input requires 0 to ±5 volts for operation over full-scale range, but can withstand many times maximum input.

5. Set frequency dial as follows:
   a. For frequency modulation with ac input, set dial for center frequency.
   b. For increasing frequency sweep with positive dc input, set dial to lower frequency limit.
   c. For decreasing frequency sweep with negative dc input, set dial to upper frequency limit.

NOTE

VERNIER control must be in full cw position for calibrated frequency operation over the .1 to 2 dial range. If this control is placed in full ccw position, dial range is uncalibrated, but extended to approximately 1/1000 of full scale.

6. Set 20 V P-P MAX control for desired output level.

Operating as a Sweep Generator

1. Set MODE selector to CONT SWP.
2. Set function selector for desired waveform.
3. Set FREQ HZ range selector to desired multiplier.
4. Set SWEEP TIME for reciprocal of desired repetition rate.
5. Set frequency dial and SWEEP WIDTH selector for desired frequency excursion; i.e., with FREQ HZ at X10K, SWEEP TIME at 1 mS, frequency dial at .6, and SWEEP WIDTH at 1.4, the output frequency will sweep from 6 kHz to 20 kHz at a 1 kHz repetition rate.
6. Set 20 V P-P MAX control for desired output level.
7. If triggered-sweep operation is desired, inject a 1 volt peak signal into the TRIG IN connector with MODE selector in TRIG SWP position. Trigger-sweep operation provides one frequency excursion of the selected waveform for each step-voltage input.

Operating as a Ramp Generator

1. Connect coaxial cable between SYNC OUT (on rear panel) and TRIG IN connectors.
2. Set function selector to sweep ⟋ .
3. Set SWEEP WIDTH to 0.
4. Set SWEEP MODE to TRIG SWP.
5. Adjust TRIG LEVEL control for sweep generator firing point.
6. Set ramp parameters as follows:
   a. Repetition rate with FREQ HZ selector and frequency dial.
   b. Ramp amplitude with 20 V P-P MAX control.
   c. Ramp slope with SWEEP TIME controls.
   d. Ramp baseline with DC OFFSET potentiometer.

SECTION 3
CIRCUIT DESCRIPTION

BASIC FUNCTION GENERATOR DESCRIPTION

Figure 3-1 is a block diagram of a basic function generator capable of delivering triangle, square, and sine wave outputs. The focal element of the basic function generator is the integrator. This stage is a high-gain wideband dc amplifier connected in an operational amplifier configuration for integration. Application of the negative half cycle of a square wave to resistor R results in a current directly proportional to the dc level of the negative portion of the square wave and inversely proportional to the value of resistor R. The operational amplifier configuration offers a very high input impedance and essentially the current in resistor R charges capacitor C. The right-hand side of capacitor C, or the output point of the amplifier, is a positive voltage slope. At a predetermined level, the positive slope switches the bistable hysteresis switch which, in turn, switches the output switch, causing the square wave to invert to its positive half cycle. The current in resistor R changes direction and capacitor C charges in the opposite polarity. The output of the integrator is now a negative voltage slope that completes the triangle waveform. When the negative slope reaches a predetermined level, it switches the hysteresis switch, which, in turn, switches the output switch, causing the negative portion of the square wave to be applied once again to resistor R. With the hysteresis switching levels fixed, the generated frequency is governed by the values of R and C and the amplitude of the applied square wave. With fixed values of R and C, varying the amplitude of the square wave picked off and applied to the integrator by the frequency adjustment potentiometer will vary the frequency. By changing the value of C, the range of frequencies over which the unit will operate with the same frequency-adjustment potentiometer can be changed. A square wave is available from the output switch and a triangle wave at the output of the integrator. The triangle wave is also fed into a converter which shapes it into a sine wave. Some attenuation is involved; therefore, a sine amplifier is added.

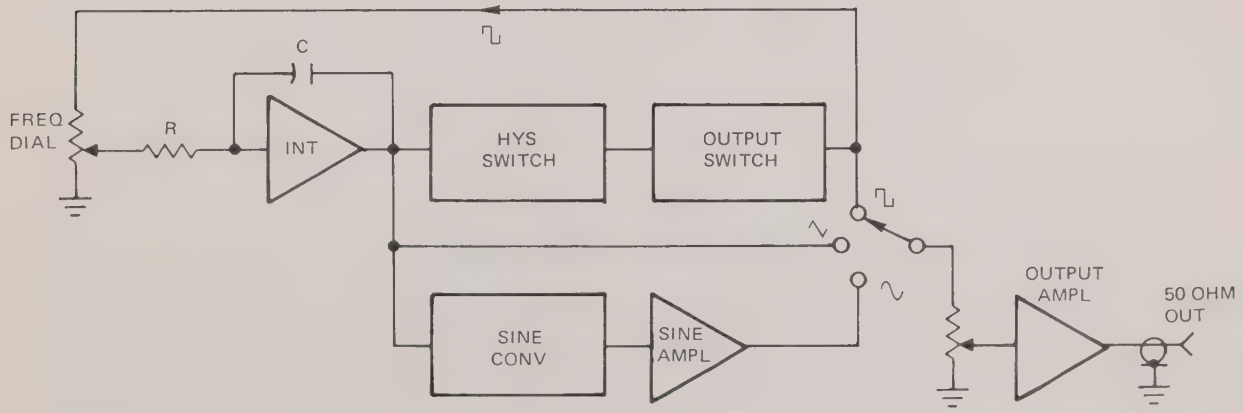


Figure 3-1. Basic Function Generator

MODEL 134 GENERAL DESCRIPTION

Continuous Mode

The Model 134 uses analog voltage control of frequency rather than the frequency potentiometer described for the basic function generator. Figure 3-2 is a simplified block diagram of the main generator in the continuous mode.

Unique circuitry in the Model 134 permits the amount of current fed to the integrator summing node to be controlled by an analog voltage. Integrating resistors R and R/2 are precisely matched and connected through a set of matched IC diodes, which are connected in opposite polarity and gate the current into the integrator summing node.

The VCG input and the frequency dial both drive an operational amplifier whose output is proportional to, but inverted from, the sum of the input voltages. The first operational amplifier drives the second operational amplifier which is designed for unity gain, but inversion about ground. As a result, a positive voltage appearing on the input causes a negative voltage at the output of the first amplifier and a positive voltage at the output of the second amplifier.

A negative square wave causes integrating current I through resistor R to be subtracted from the current 2I through resistor R/2 and thus causes net integrating current I to flow out of the integrator summing node. A positive square wave voltage causes the diode in the current path through resistor R/2 to be switched off. Thus, only integrating current I flows through R into the summing node of the integrator.

The circuit would be complete and work accurately except for the small drop across the switching diodes. This drop is compensated by a matching IC diode in the feedback loop of the operational amplifiers. The current through the compensating diodes equals the current through the switching diodes. The switching diodes and the operational amplifiers have good high-frequency characteristics since square waves up to 2 MHz must be controlled. As a result, the basic circuitry is also capable of wideband frequency modulation.

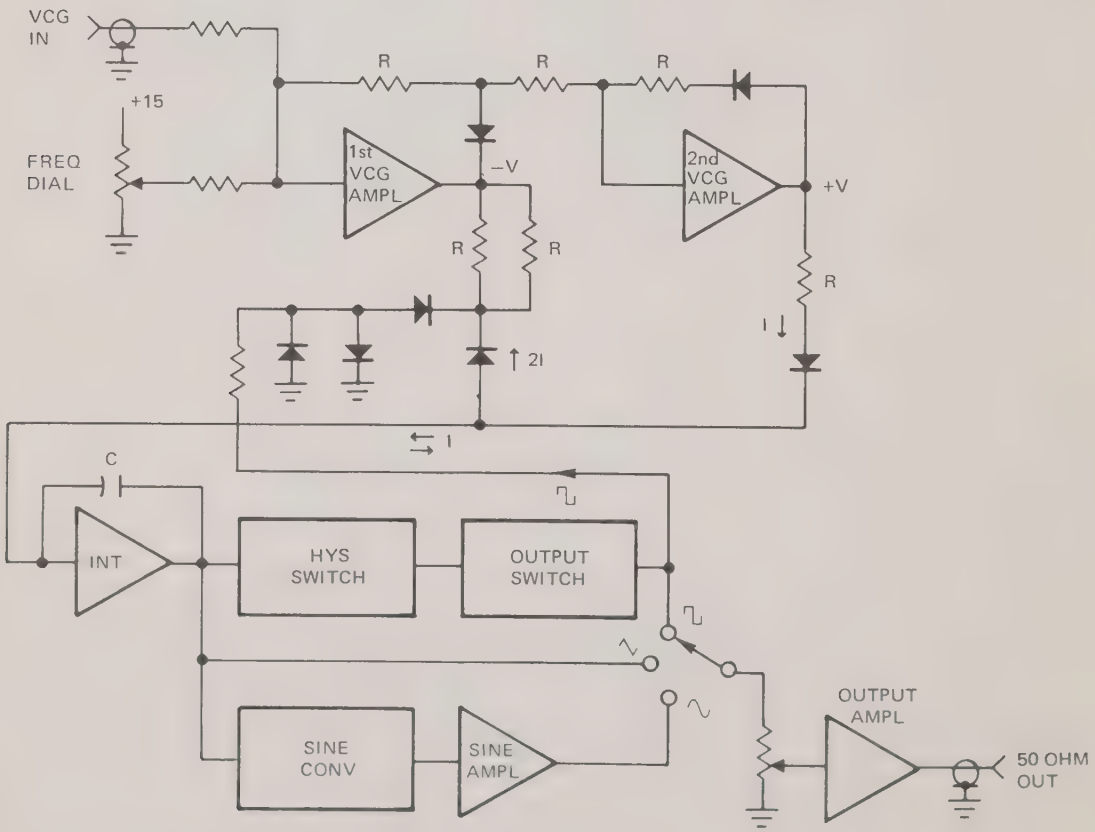


Figure 3-2. Continuous Mode

Triggered/Gated Modes

Figure 3-3 is a simplified block diagram of the triggered mode. When the Model 134 is in the triggered mode and ready, the output of the trigger/gate control is at the positive potential. Q3 is off and Q4 and Q5 are on, clamping the output of the integrator at the level set by reference level potentiometer R50. When a triggering signal

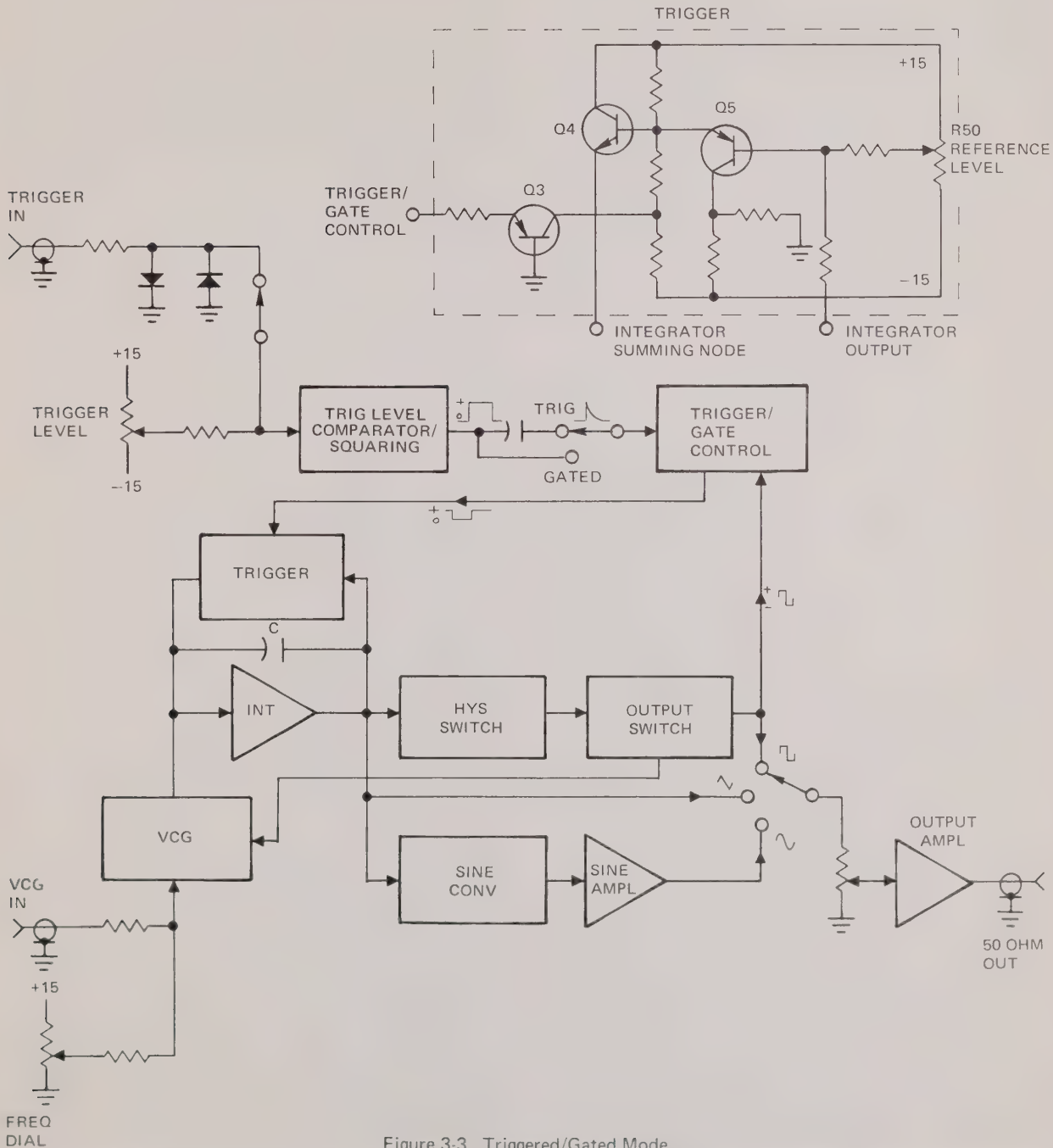


Figure 3-3. Triggered/Gated Mode

that overcomes the level set by the TRIG LEVEL control is applied to the TRIG IN connector, the trigger/gate control steps to near ground potential, turning off Q3 The junction of the Q4 base and the Q5 emitter is driven negative, disconnecting the shunting path formed by Q4 and Q5 and allowing the integrator to start. The dc level at which it starts is set by the reference level potentiometer. The trigger/gate control is reset by the square wave from the output switch. Resetting the trigger/gate turns on Q3, enabling the Q4/Q5 clamp once again; however, the triangle output must reach the reference level before the clamp takes control. This ensures that the integrator output always starts and stops at the level set by the reference level potentiometer. When in the triggered mode, one cycle is generated each time a triggering signal is applied.

When in the gated mode, the output of the squaring circuit is coupled directly to the trigger/gate control (Figure 3-3). The sequence of operation is the same as in the triggered mode, except that one or more cycles are generated for the duration of the trigger signal applied at the TRIG IN connector.

Sweep Modes

In the sweep modes of operation, a third input is added to the VCG amplifiers. This is the output of the sweep generator. The sweep generator is essentially an integrator with different integration time on the positive and negative slopes. The input stage of the amplifier is a differential pair of Darlington-connected emitter followers that minimize loading of the input summing junction. When enabled, the

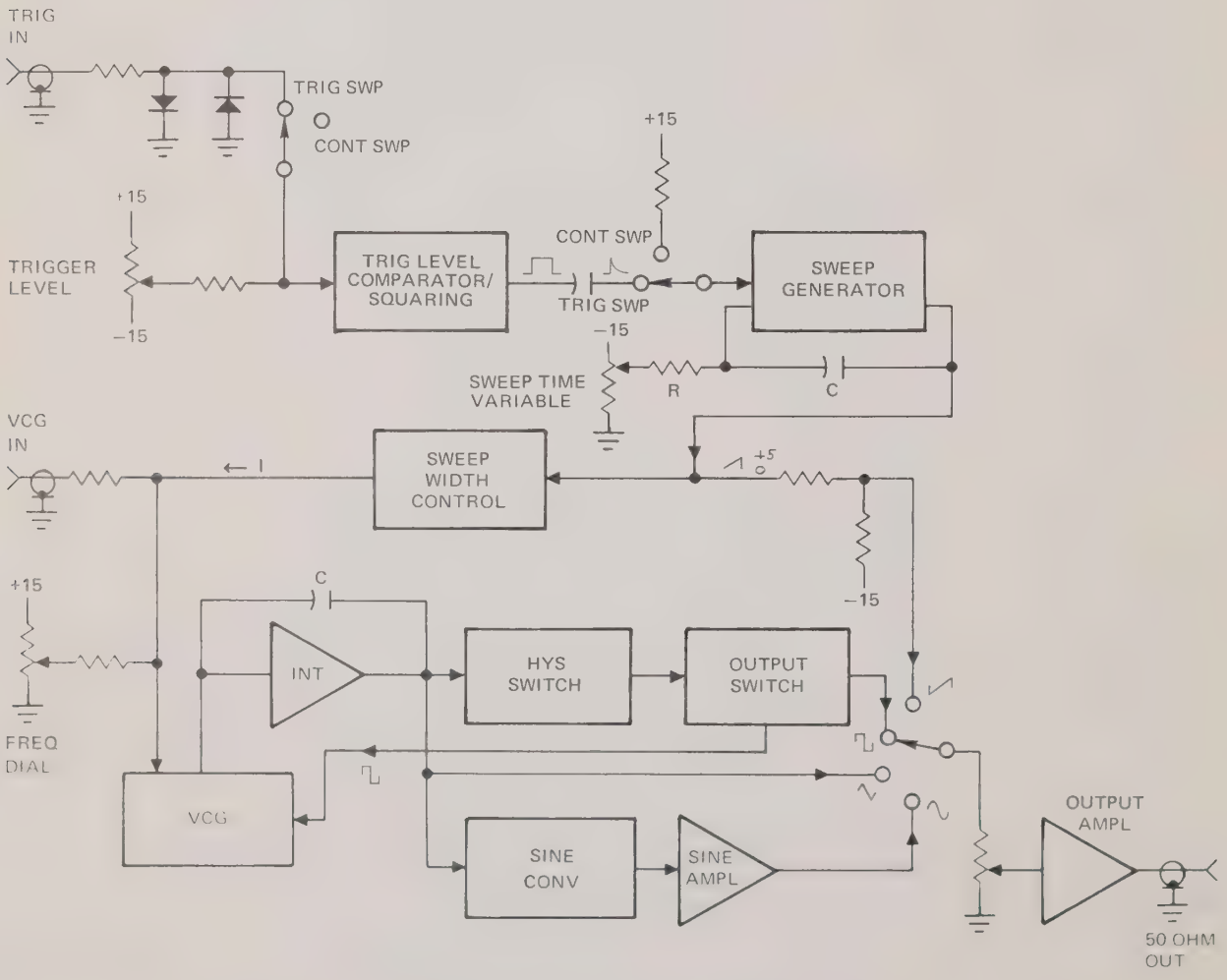


Figure 3-4. Continuous and Triggered Sweep Modes

sweep generator output voltages rise linearly from zero at a rate determined by the timing capacitor and the VARIABLE SWEEP TIME potentiometer. The SWEEP WIDTH switch and VARIABLE potentiometer control the amount of maximum current to be applied to the first VCG amplifier summing node, causing the main integrator output frequency to rise linearly. The timing capacitors are changed by the SWEEP TIME switch.

In the continuous-sweep mode (Figure 3-4), the sweep generator and the main generator run continuously. The basic frequency of the generator is set by the frequency dial, the VERNIER, and the FREQ HZ switch. As the sweep generator output starts moving positive, the frequency increases linearly since the output of the sweep generator is coupled through the SWEEP WIDTH control to the first VCG amplifier summing node. Maximum frequency is the sum of the basic frequency and sweep width. The sum of the frequency dial setting and the SWEEP WIDTH switch position should not exceed 2.0. It is to be noted that maximum sweep width (2.0) is usable only when the basic frequency is nearly zero or less than one hundredth of the dial. The sweep output repeats as long as the MODE switch is in the CONT SWP position. The SWEEP TIME switch and VARIABLE control select the repetition rate.

When in the triggered-sweep mode (Figure 3-4), the main generator runs continuously at the frequency set by the frequency dial, VERNIER control, and the FREQ HZ switch. The sweep generator is initially inoperative. When an input trigger signal is applied at the TRIG IN connector, the output of the trigger level comparator/squaring circuit steps from zero to approximately +5 volts. The positive voltage step is coupled through a capacitor and creates the differentiated pulse. The duration of the pulse is long enough to release the sweep generator clamp for a single cycle. Thus, a single sweep of the main generator is accomplished. The operation of the SWEEP WIDTH switch and VARIABLE potentiometer is the same as in the continuous-sweep mode.

Figure 3-5 is a simplified block diagram of the Model 134 in the tone-burst mode. No new circuitry is introduced in this diagram. This mode is essentially the same as the gated mode except that the gating pulse for the main generator is created by internally coupling the sawtooth output of the sweep generator to the trigger level comparator/squaring circuit. The sweep generator runs freely at the sweep time set by the SWEEP TIME switch and VARIABLE potentiometer. The duration of the gating pulse is determined by changing the trigger level of the sawtooth wave. The frequency of the tone burst is changed with the FREQ HZ switch, the frequency dial, and the VERNIER control. Tone-burst repetition rate may be varied by the SWEEP TIME switch and VARIABLE potentiometer.

DETAILED DESCRIPTION

VCG Amplifiers

The two VCG amplifiers which are shown on the Main Board schematic diagram, are similar operational inverting amplifier configurations. The basic operational amplifier is a μA709C integrated circuit. IC1, the first inverting operational VCG amplifier, serves as the main frequency control. The dial voltage from the dial potentiometer is applied through R4, R5, and R6 to the summing node of the operational amplifier.

The voltage from frequency VERNIER potentiometer R10, is applied through R9 to the summing node of the operational amplifier. Any voltage applied to the front panel VCG IN connector is applied through R3 to the summing node of the operational amplifier. The first VCG amplifier also accepts, at its summing node, the sweep generator output through the SWEEP WIDTH control. The resultant VCG output is proportional to the sum of the input voltages.

Resistors R11, R12, and R13 provide a zero adjustment network for the summing node of the operational amplifier. R7 and R8 provide source current for the input of the first amplifier, allowing frequency adjustment at one-thousandth of the dial. R14 is the feedback resistor in the first operational amplifier.

The square-wave output from the output switch is applied through R16 to the anode of IC2d. When the square wave is negative, IC2d is turned off and the output of the first VCG amplifier is coupled through IC2b to the summing node of the integrator. R18, R19, and R20 form the first VCG amplifier integrating resistors.

When the square wave is positive, IC2d conducts and the cathode of IC2b will be at ground potential, inhibiting current flow through IC2b. IC2c, in the feedback loop of the first operational amplifier, compensates for the voltage drop across IC2b. This arrangement also temperature compensates the first VCG amplifier.

The first operational amplifier has a gain of approximately 2/5 with respect to the dial input, and the second operational amplifier has a gain of unity. The output of the first VCG amplifier is coupled through R21 to the summing node of the second operational amplifier.

Resistor R181 is the feedback resistor in the second operational amplifier. IC2a and IC2f diodes, in the second operational amplifier, are compensation elements for temperature and diode voltage-drop variations.

However, the output of the second operational amplifier is always positive; therefore, the diode polarities are reversed. The output of the second VCG amplifier is connected to the integrator summing node through the second VCG amplifier integrating resistor R27, and IC2a.

Since the second VCG amplifier has unity gain, it will provide an output of opposite polarity and equal magnitude as the output of the first VCG amplifier. The precise gains of the VCG amplifiers and the precise integrating currents are obtained by matching R14, R18, R19, R21, R27, and R181.

A negative square wave at the anode of IC2d causes the integrating current through R27 to be subtracted from the current through R18, and R19, and thus causes the net integrating current to flow out of the integrator summing node. A positive square wave voltage causes IC2b to be switched off. Thus, the integrating current through R27 flows into the summing node of the integrator.

Resistors R22, R23, and R24 serve as the zero adjustment control for the second VCG amplifier. R22 allows adjustment of the time symmetry at the minimum of the dial.

Integrator

Stages IC4, IC5, Q1, and Q2 make up the wideband dc integrator amplifier. The FREQ HZ switch selects the appropriate integrating capacitors for frequency ranging.

Stage IC4 is a Darlington input pair for the inputs. Four transistors in IC4 are low current, high gain, wideband

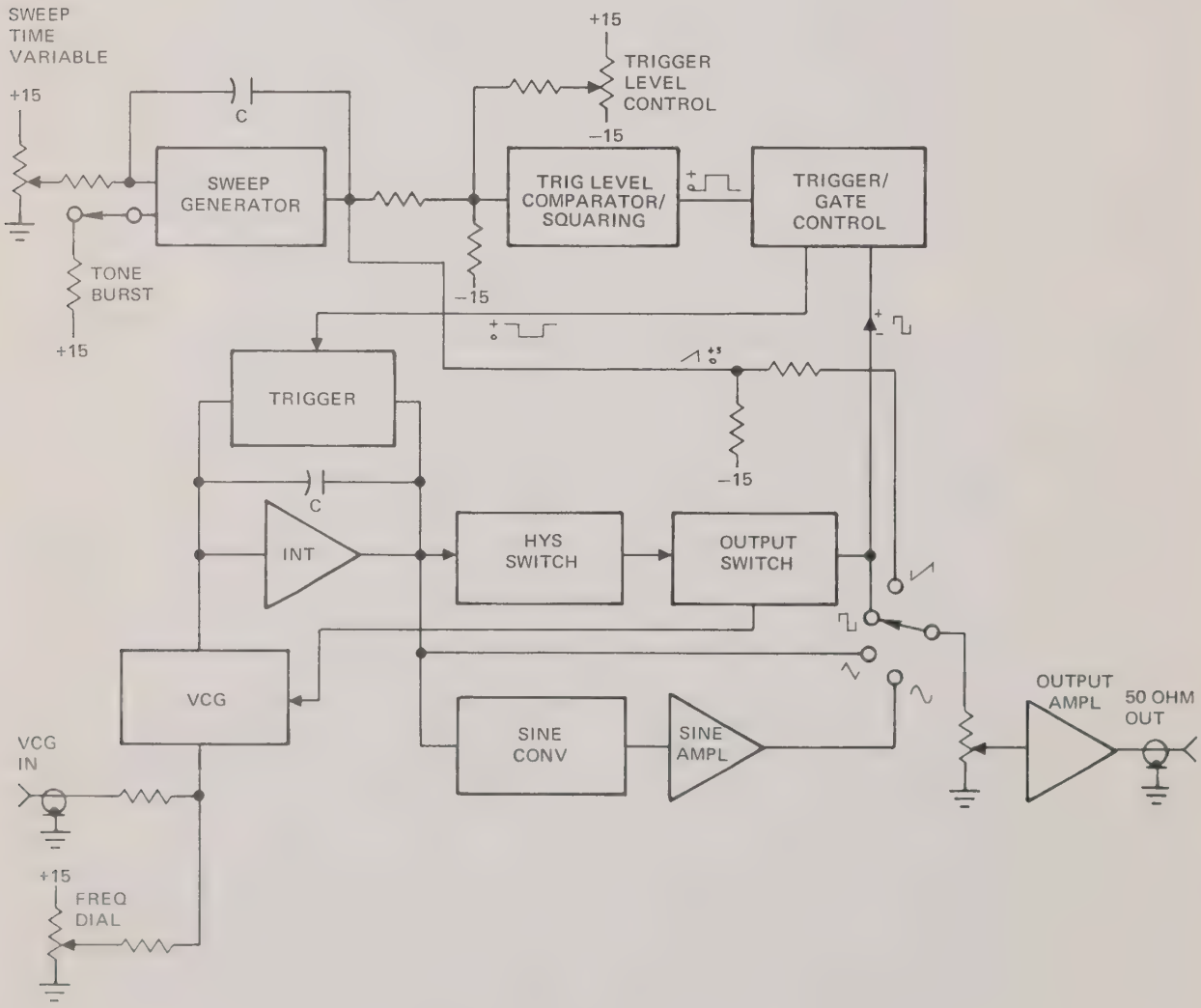


Figure 3-5. Tone Burst Mode

transistors that allow the inputs to operate with negligible source current. The output is taken off at the output of IC5 and coupled through push-pull emitter follower Q1/Q2. CR5 and CR6 provide the bias voltage for Q1 and Q2 to prevent crossover distortion. R28 allows the dc levels in the two sides of the amplifier to be balanced throughout. The triangle output is connected to the sine converter and fed through R51 to hysteresis switch Q6-Q11.

Trigger

Transistors Q3 and Q5 form an indirect shunting path from the output to the input summing node of the integrator. Q4 is connected in a grounded-base configuration and functions as a switch for the shunt circuit.

When the main generator trigger input (pin G) is grounded, the emitter of Q4 is at ground potential. Since the base of Q4 is grounded, Q4 is off and the collector potential is at approximately −7 volts. Since the junction of R43 and R44 is at approximately ground potential, current is not flowing into the integrator summing node through Q3. Thus, only the integrating current from the VCG circuit is flowing in and out of the summing node. The base of Q5 is driven by the integrator output to positive and negative directions but the emitter is restricted from exceeding ground potential by voltage divider R43 and the sum of R44 and R45. Therefore, Q5 does not affect the off condition of Q3.

When a positive voltage is applied to the trigger input, Q4 turns on. The junction of R44 and R45 is near ground potential. The base drive for Q3 is supplied through R43. Thus, current flows into the integrator summing node overcoming the integrating current and the output is driven negative. The base of Q5 is driven negative, coupled through R48, reducing the base drive current of Q3. Thus, the current flowing into the summing node is reduced until the quiescent condition is reached with the integrator output nominally at zero volts. Transistors Q3 and Q5 act as an indirect negative feedback path for the integrator. R50 provides the reference level adjustment for the integrator output, biasing the base current of Q5.

Hysteresis and Output Switch

The transistors in the hysteresis switch are connected to form a bistable switch. Either the Q6, Q7 side or the Q9, Q10 side can be on but not both at the same time. When the positive triangle slope reaches the firing level set by R56, the Q7 side turns on and the Q10 side turns off. The triangle starts its negative slope and when it reaches the firing level set by R59, the Q10 side turns on and the Q7 side turns off. The hysteresis switch is dc coupled to the bistable output switch made up of Q13-Q16.

The 10-volt peak-to-peak square wave is fed through R73 to the SYNC OUT connector. The square wave is also coupled to the output amplifier through the function switch after the 10-volt peak-to-peak square wave is divided by R84 and R85.

Sine Converter and Amplifier

Wavetek Model 130-011 Sine Converter is a sealed subassembly that contains temperature-compensated, matched diodes, and precise current-biasing resistive networks. When a precise triangle wave is fed into the shaping network through voltage divider R123 and R124, the subassembly shapes the triangle wave into a sine wave.

The positive portion of the triangle is set by R126 through pin 4 (+V) and the negative portion is set by R127 through pin 1 (−V). Therefore, the input to the sine amplifier is a sine wave terminated with a 50Ω load in the subassembly. The sine wave is fed directly to the plus input of the sine amplifier. Sine amplifier IC8 is a dc wideband operational IC amplifier connected in a potentiometric configuration. R131 is the feedback resistor, R128 adjusts the sine symmetry about ground, and R133 adjusts the sine wave amplitude.

Output Amplifier

Q34 through Q40 form an operational output amplifier, connected in a potentiometric configuration, with a gain of approximately eight set by feedback resistors R145 and R151. Transistor Q34 is a differential input stage driving the second differential stage of Q37 and Q38. Q35 together with R141, R152, R153, Q36, and CR18 form a constant current generator for the Q34 differential amplifier stage. Q36, connected as a diode, compensates base-emitter junction voltage change of Q35 due to temperature variations. R141, together with the divider formed by R152 and R153, sets the constant current output. CR18 compensates the current output change due to base-emitter junction voltage change of Q37 and Q38 caused by temperature variations. The output is taken off single ended at the collector of Q38 and coupled to the push-pull emitter follower Q39/Q40. Diodes CR16 and CR17 provide bias for the push-pull emitter follower to prevent crossover distortion. The output is coupled through R165, R166, R167, and R168 to 50Ω OUT connector. The input is selected on the front panel and is applied through SW3. The input is attenuated by the amplitude-adjustment potentiometer R135. Maximum attenuation is approximately 40 db. R172 serves as a dc offset control allowing the power amplifier output to be offset approximately ±5 V dc. (Using the offset control limits the available peak output signal.) The output will deliver 100 mA into a 50Ω load and 20 volts peak-to-peak into an open circuit. When terminated in 50 ohms, the amplifier will deliver 10 volts peak-to-peak. When the amplifier is offset maximum and terminated in 50 ohms, the output is limited to 5 volts peak-to-peak.

Capacitor C64 allows the amplifier to be high-frequency

compensated. It is adjusted to give the best square wave response without peaking when a 2 MHz square wave is applied. The unregulated ±22 volts dc provides the supply voltages for the push-pull emitter follower of the output amplifier. The rest of the circuit operates on the regulated ±15 volts dc. R150 is the dc balance control that allows the output to be adjusted for symmetry about ground.

Trigger Level Comparator/Squaring Circuit

Q2a and Q2b make up a comparator amplifier with Q1 providing positive feedback from the Q2b collector to the Q2a base. (See Sweep Board schematic diagram.) When the positive portion of an input triggering signal overcomes the trigger level set by R23, Q2a turns on, forcing Q2b to turn off. As the collector of Q2b moves in the positive direction, Q1 drives current into the base of Q2a coupled through R25, speeding up the latching action. When the negative portion of an input triggering signal overcomes the hysteresis established by R25, Q2a turns off, forcing Q2b to turn on. Thus, the output of the trigger level comparator at the Q2b collector is a pulse with rapid rise and fall time. The output pulse will have a duration determined by the width of the input pulse applied at the TRIG IN and by the TRIG LEVEL control, except when a step voltage is applied.

Q3 and Q4 are inverting saturated switches which further reduce the rise and fall time of a gating pulse created by the trigger level comparator.

Trigger/Gate Control

The trigger/gate control is best understood by studying the timing relationship when the generator is in the GATED mode (see Figure 3-6). When an external trigger signal is applied at the TRIG IN connector and the trigger level is adjusted, a gating pulse appears at the collector of Q4. The pulse is coupled through the emitter follower Q5 to the direct clear (C_d) input of IC1, J-K flip-flop. The positive signal at C_d input forces the output Q to change state and remain at ground potential, thus removing the shunt path of the integrator in the main generator. The integrator output moves initially in the positive direction since the output switch is at negative potential when the generator is in standby state. The generator functions normally for the duration of the gating pulse. Although the sync pulse is applied to the trigger input of IC1, the input signal is overriden by the positive gating potential at C_d and the output Q remains at ground potential.

When the gating signal returns to ground potential, IC1 is ready to be cleared by the next negative portion of the sync pulse. When IC1 is cleared, the integrator output is detected by the trigger circuit in the main generator and the shunt path is re-established, thus placing the main generator in standby state. Q6 is an emitter follower that provides +3.6 volts for IC1. The R38/R41 divider establishes the base voltage.

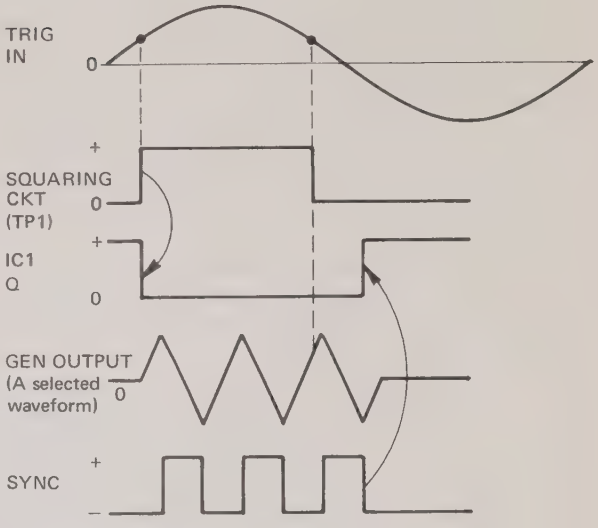


Figure 3-6. Gated Mode Timing Diagram

Sweep Generator

Stages IC2 and IC3 are the wideband dc integrator amplifier. The SWEEP TIME switch selects the appropriate integrating capacitors for sweep time ranging. IC2 is a Darlington-input pair for the inputs. Four transistors in IC2 are low current, high gain, wideband transistors which allow the input to operate with negligible source current.

When Q9 is on, the only input to the integrator is the voltage appearing on the arm of the SWEEP TIME VARIABLE control R42. The voltage is applied through the input resistors, R46 and R47, to the inverting input of the amplifier. Since the current flows out of summing node through R46 and R47, the output of the integrator is a positive section of a ramp.

Q13a and Q13b make up a comparator amplifier with Q10 providing a positive feedback from Q13b collector to Q13a base. Q13b base is referenced at ground potential. When the ramp reaches +5 volts, Q13a base is slightly above the ground potential established by the junction of the divider of R61 and R62/R63. Q13a turns on, causing the collector of Q13b to move in positive direction. Q10 aids the switching time of the differential pair in turning off Q9.

Q7 and Q8 make up another comparator amplifier. The base of Q7 is biased by the divider of R53, R54, and R55. Since the output of the integrator is at +5 volts, the R58/R59 divider biases the Q8 base at higher potential than the Q7 base with both emitters connected and biased to +15 volts through R57. Thus, Q7 turns on and couples R57

to the summing node of the integrator. The current through R57 flows into the summing node, overcoming the current flowing out of the node through R46 and R47. The net result is an integration current flowing into the node, and the negative slope of the ramp is generated. Since the ratio of the integration current flowing in and out of the summing node is greater than 25 to 1, the output of the integrator is a sawtooth wave with a slope ratio of greater than 20 to 1. When the negative slope reaches ground potential, Q8 base is at lower potential than Q7 base. Q8 turns on, forcing Q7 to turn off.

The current through R57 is now coupled through Q8 to R60 and Q12 base. Q11 is normally off, allowing the continuous sawtooth generation. In the triggered sweep mode, Q11 is normally on, allowing the integrator to remain at standby state except when a differentiated pulse with a short duration triggers the base of Q11. In the continuous sweep mode, Q11 is off, allowing Q12 to turn on. Since the base drive of Q10 is grounded through Q12, the Q13a base is at slightly lower than ground potential. Q13a turns off and turns Q9 on. The current through R57 now flows through Q9 and the cycle is completed.

Sweep Width Control

Resistors R1 through R12, R21, R22, and switch SW3 form the sweep width control. When the generator is in CONT SWP or TRIG SWP modes, the sweep generator output is coupled through the sweep width control to the summing node of the first VCG amplifier. Since the sweep generator output is fixed at the constant peak amplitude of +5 volts, the peak current flowing into the summing node of the first VCG amplifier is adjusted by changing resistors. The peak current is inversely proportional to the resistance in the path and is proportional to the generator peak frequency.

Switch SW3 with R1 through R12 creates nine discrete steps of resistance; R, R/2, R/3, . . ., R/8, and R/9. This controls the amount of the peak frequency change added to the basic generator frequency set by the frequency dial, VERNIER control, and VCG IN signal. R22 is a variable adjustment potentiometer which controls the signal between the discrete steps.

Power Supply

Ac voltage is coupled from the transformer secondary to the bridge rectifier CR11-CR14. Filtering is provided by C48 and C49. Q25 is a transistor connected and operated as a zener diode to provide a reference voltage for the +15 volt supply. IC6 is a comparator differential amplifier. This stage drives a Darlington-connected pass transistor pair, Q17 and Q18. The pair is formed for added current gain. Q20 is a transistor connected and operated as a zener diode to provide a voltage level shift for the IC6 output. R104 allows the minus input of IC6 to be adjusted slightly negative with respect to the plus input, which has a zener voltage of approximately 6.3 volts. R104 is adjusted to give an output of +15.0 volts. If the +15.0 volts tries to increase due to a change in line voltage or load current, the collector of Q25 stays approximately at the same voltage. Thus, the minus input of IC7 becomes more positive than the plus and the IC6 output draws more current. The output moves less positive and this change is coupled through Q20 to the bases of Q17 and Q18. This returns the supply to +15.0 volts.

IC7 is a comparator differential amplifier in the −15.0 volt regulator. The plus input of IC7 is returned to ground through R107. The divider of matched resistors, R106 and R108, between the plus and minus 15 volt supplies sets the minus input of IC6 precisely at ground. An increase in −15.0 volts, due to line voltage variation or load current variation, results in the minus input of IC7 moving negative. The IC7 output moves less negative (in a positive direction). This change is coupled to the bases of Q23 and Q24 through Q21. Q23 and Q24 form a Darlington-connected pass transistor pair for added gain. The positive-going change returns the output to −15.0 volts.

Q19, with R90 through R92, form a foldback current limiter for the +15 volt regulator. Normally the base of Q19 is biased more negative than the emitter and Q19 is turned off. Thus, the base of Q18 moves freely as IC6 output changes. When the +15 volt output is overloaded, heavy current flows through R90 and creates a potential drop across the resistor.

When the potential drop overcomes the drop across R91, Q19 begins to conduct, thus starting to short the base of Q18 to the +15 volt output. In this condition, the output can be shorted indefinitely at lower than the maximum power dissipation of Q17. When the overload condition is removed from the +15 volt output, the base of Q18 starts to rise. As the emitter of Q17 rises toward +15 volts, divider R91/R92 has more effect on the base of Q19 and eventually turns off Q19 completely. When it turns off, the normal condition is restored. Q22, with R93, R94, and R95, form a foldback current limiter for the −15 volt regulator.

SECTION 4
MAINTENANCE

INTRODUCTION

This section provides instructions for testing, calibrating, troubleshooting, and repairing the Model 134. The instructions are concise and for the experienced electronics technician or field engineer. Wavetek maintains a factory-repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to facilitate the turnaround time. Test point and adjustment locations are illustrated in Section 5.

RECOMMENDED TEST EQUIPMENT

Table 4-1 contains a list of recommended test equipment. Any test equipment having equivalent accuracies may be substituted for those listed.

Table 4-1. TEST EQUIPMENT

Name	Required Characteristics	Recommended Manufacturer	Model
Oscilloscope	To 30 MHz	Tektronix	544
Plug-In	Dual channel	Tektronix	1A1
Plug-In	Peak mV measuring capability	Tektronix	1A5
Distortion Analyzer	To 600 kHz	Hewlett-Packard	334A
Spectrum Analyzer Display	To 50 MHz	Hewlett-Packard	141S
IF Section		Hewlett Packard	8552A
RF Section		Hewlett Packard	8553L
Dialamatic Voltmeter	Millivolt dc measurement	Wavetek	201
Counter	To 10 MHz	0.1% of reading accuracy	

CHECKOUT AND CALIBRATION

The following paragraphs provide complete sequential calibration procedures for the Model 134. Instrument checkout procedures are indicated by a checkmark (√) following the procedure title. A quick checkout of the instrument can be performed by comparing the indicated parameters with the tolerances given in the **Specifications** of Section 1.

NOTE

The entire calibration procedure *must* be read first to determine initial control settings and test equipment connections before attempting checkout.

Preliminary Procedures

1. Set FREQ HZ selector to the X1K position and VERNIER control maximum cw.
2. Set MODE selector to CONT, SWEEP WIDTH to 1.0, and SWEEP TIME to 1 mS.
3. Allow one-half hour for warmup.

Power Supply Regulation

1. Connect voltmeter between TP1 (common) and TP2 (+) on Main Board. Adjust R104 for +15 Vdc ±100 mV.
2. Connect voltmeter between TP1 (common) and TP3 (–). Since the negative supply is referenced to the +15-volt supply, the voltmeter should indicate –15 Vdc ±100 mV.

Square Wave Amplitude Symmetry

1. Set function selector to ⊓⊔ .
2. Connect oscilloscope, with 1A5 plug-in, to coaxial-wire lug on function switch.
3. Adjust R121 until square-wave negative peak is equal in amplitude to positive peak ±5 mV.

Output Amplifier √

1. Connect oscilloscope to 50Ω OUT connector with 50-ohm terminator (⊓⊔ function).
2. Set FREQ HZ selector for X1K (VERNIER full cw) and frequency dial at 2.0.
3. Turn 20 V P-P MAX control fully ccw.
4. Adjust R150 for amplitude symmetry about ground.
5. Set FREQ HZ selector for X1M (2.0 dial setting).

6. Turn 20 V P-P MAX control fully cw.
7. Adjust C64 for best square-wave response without peaking.

First VCG Null √

1. Connect oscilloscope to 50Ω OUT connector.
2. Set FREQ HZ selector to X1K. Set dial at 1/100 of full scale.
3. Short and open VCG IN to signal ground (outside of BNC connector) while monitoring output frequency variation. Adjust R11 for minimum frequency change.

Triangle Amplitude

1. Set frequency dial for 2.0 (X1K range) and function selector to ∿ .
2. Connect oscilloscope, with 1A5 plug-in, to red-wire lug on function switch.
3. Adjust R56 on main board for positive peak at +1.25 volts ±5 mV (see sketch).
4. Adjust R59 for negative peak at −1.25 volts ±5 mV.

Negative Peak

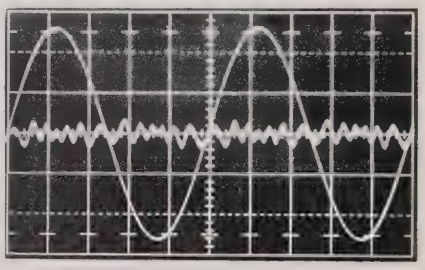
Positive Peak

Time Symmetry √

1. Connect unit and oscilloscope, with 1A1 plug-in set for alternate display, as shown in Figure 4-1.
2. Set FREQ HZ selector for X100K with VERNIER in full cw position (⊓ function).
3. Set frequency dial for 2 kHz on oscilloscope (1/100 dial FS).
4. Adjust R28 for time symmetry at 100:1 frequency ratio.
5. Turn VERNIER fully ccw and adjust R22 for bottom-of-dial time symmetry.
6. Repeat Steps 4 and 5, as necessary, for optimum symmetry.
7. Check for waveform time symmetry at the .2 and 2 frequency-dial settings.

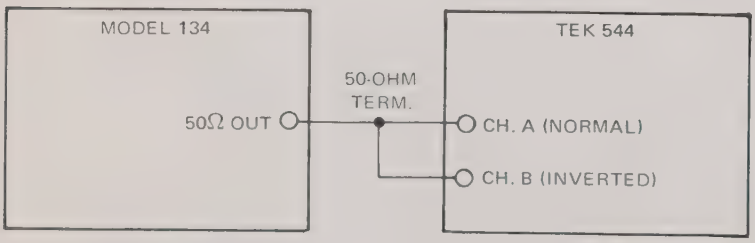
Sine Distortion, Amplitude, and Balance √

1. Set FREQ HZ selector for X1K (VERNIER full cw), function selector to ∿ and frequency dial at 2.0.
2. Connect oscilloscope, with 1A5 plug-in, to orange wire on function switch.
3. Adjust R128 to balance output.
4. Adjust R133 to obtain 2.5 V p-p ±25 mV output.
5. Connect the unit, distortion analyzer, and oscilloscope as shown in Figure 4-2.
6. Adjust R126 and R127 for minimum sine distortion (see photo).
7. Set FREQ HZ selector by X10K.
8. Repeat Step 6 to obtain least distortion at both X1K and X10K ranges.
9. Repeat Steps 2, 3, and 4.
10. Connect spectrum analyzer to unit as shown in Figure 4-3. Check sine distortion at 2 MHz.



Frequency Dial Alignment √

1. Connect counter to 50Ω OUT connector.
2. Set FREQ HZ selector to X10K and VERNIER fully cw.



Trigger: Internal

Display: Alternate

Time Base: 50 microseconds/cm for 1/100 of 200 kHz
500 microseconds/cm for 1/1000 of 200 kHz

Figure 4-1. Time Symmetry Measurement Test Set-Up

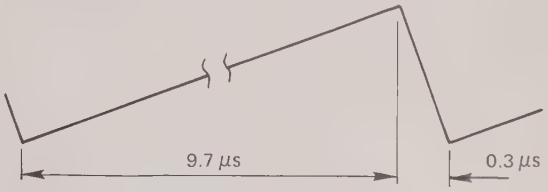
3. Set frequency dial potentiometer for 2 kHz on the counter display.
4. Align 0.2 dial mark with the dial indicator index and tighten set screw.
5. Align 2.0 dial mark with the dial indicator index and adjust R4 to obtain maximum dial accuracy on bottom four ranges.
6. Set FREQ HZ selector to X100K and dial fully cw.
7. Turn frequency VERNIER fully ccw.
8. Adjust R8 for 150 ±20 Hz on counter.
9. Check that generator continues to oscillate over the full range of the frequency VERNIER dial. If not, readjust R8.
10. Turn VERNIER fully cw (CAL) and set frequency dial to align 2.0 with index mark.
11. Adjust C16 to obtain 200.0 kHz on counter display.
12. Set FREQ HZ selector to X1M. Adjust C12 to obtain 2.00 MHz on counter display.

Sweep Amplitude √

1. Connect oscilloscope, with 1A5 plug-in, to SWEEP OUT connector.
2. Set SWEEP TIME for 1 mS with VARIABLE fully cw.
3. Adjust R54 for 0 volts ±25 mV.
4. Connect oscilloscope to SWEEP OUT connector.
5. Adjust R63 for +5 volts ±25 mV.

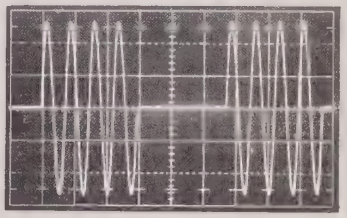
Sweep Time √

1. Connect oscilloscope to SWEEP OUT connector.
2. Set SWEEP TIME selector for 10 μS with VARIABLE fully cw.
3. Adjust C19 on Sweep Board to obtain approximately 10 microsecond sawtooth duration (see sketch).



Trigger/Gated Output √

1. Connect oscilloscope to 50Ω OUT connector.
2. Set FREQ HZ selector to X10K and FREQ dial for 2.0
3. Set MODE selector for TONE BURST (SWEEP TIME 1 mS, VARIABLE full cw).
4. Adjust TRIG LEVEL for appropriate tone-burst pattern.
5. Adjust R50 on main board until baseline is 0 volts ±50 mV (see photo).



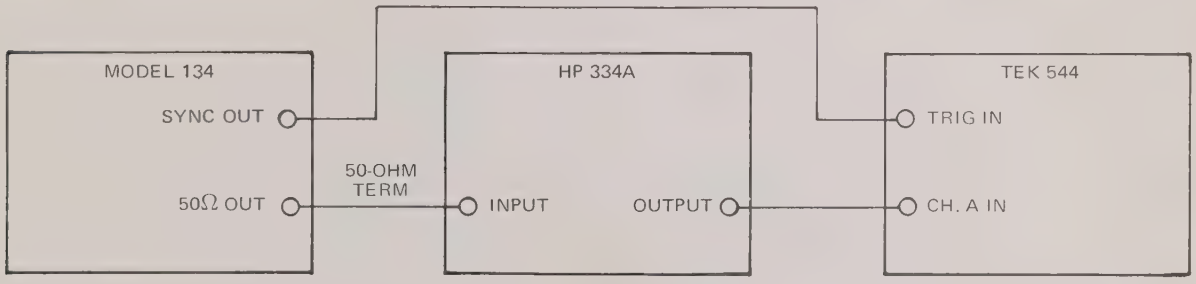


Figure 4-2. Distortion Analysis Test Set-Up

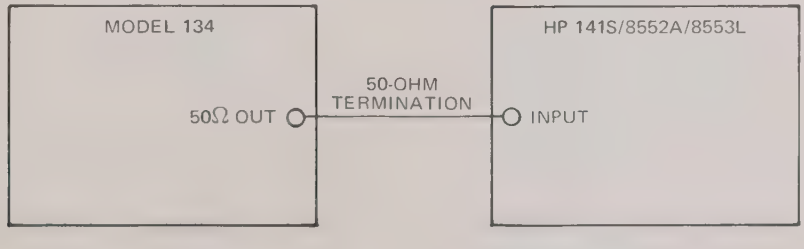


Figure 4-3. Spectrum Analysis Test Set-Up

TROUBLESHOOTING

Basic Techniques

Troubleshooting the Model 134 requires no special techniques. Listed below are a few reminders of basic electronics fault isolation.

1. Check control settings carefully. Many times an incorrect control setting, or a knob that has loosened on its shaft, will cause a false indication of a malfunction.
2. Check associated equipment connections. Make sure that all connections are properly connected to the correct connector.
3. Perform the checkout procedure. Many out-of-specification indications can be corrected by performing specific calibration procedures.
4. Visually check the interior of the instrument. Look for such indications as broken wires, charred components, loose leads, etc.

Troubleshooting Chart

Table 4-2 provides a list of possible malfunction symptoms, probable causes, prescribed remedies, test points at which measurements are made, and parameter tolerances at these points. To use the troubleshooting chart, locate the symptom listed in Column 1 and follow the corresponding procedures. Localize the fault to a specific stage by checking the parameters given for the major test points. Then check the dc operating voltages at the pins of solid-state devices. Check associated passive elements with a high input impedance ohmmeter (power off) before replacing a suspected semiconductor element.

Table 4-2. TROUBLESHOOTING CHART

Symptom	Probable Cause	Corrective Procedures
No outputs at 50Ω OUT connector	Blown fuse	Replace F1 a. 1/4A–115 Vac b. 1/8A–230 Vac
	Power supply	Check TP1/TP2 for +15V; TP1/TP3 for –15V; TP1/TP5 for +6V; TP1/TP6 for –6V. Troubleshoot associated regulator.
	Output amplifier	Check at wiper (grn/wht wire) of function selector switch for waveform as selected by position of switch. a. If waveform is present, troubleshoot output amplifier. b. If no waveforms are present, refer to **Main Generator Troubleshooting Hints**.
No sine wave output	Sine amplifier	Check for 260 mV p-p sine wave at pin 4 of IC8. a. If present, check IC8 circuit. b. If *not* present, check A1 circuit. *NOTE*: Triangle wave must be present at pin 2 of A1 to obtain sinewave output.
No triangle, sine, or square wave.	Generator loop	Refer to **Main Generator Troubleshooting Hints**.
All waveforms low in amplitude.	Power amplifier	a. Check front-panel amplitude control. b. Perform balance adjustment for power amplifier.
	Power supply	Check for proper voltages.
Frequency out of tolerance	Power supply	Check for proper power supply voltages as stated above.

Table 4-2. TROUBLESHOOTING CHART CONT.

Symptom	Probable Cause	Corrective Procedures
	Maladjustment	Perform calibration procedure.
Sine wave not in spec	Maladjustment	Perform **Sine Distortion, Amplitude**, and **Balance** adjustment.
	Sine converter	Check for 260 mV p-p sine wave at pin 4 of IC8. a. If normal, check sine amplifier IC8. b. If abnormal, check A1 circuit.
Time symmetry of waveforms not correct	Maladjustment	Perform **Time Symmetry** and frequency adjustments.
Triggered, gated, tone burst, and triggered sweep modes inoperative; continuous sweep normal.	Trigger comparator fault	Check at R32/R33 junction (sweep board) for +5V with trigger level control fully cw. If abnormal, check Q1-Q4 on sweep board.
Triggered, gated, and tone burst modes inoperative; triggered sweep and continuous normal	Trigger/gate controller fault or trigger circuit failure	Check Q5/IC1/Q6 on sweep board and Q3-Q5 on main board.
Sawtooth sweep not in spec	Maladjustment	Perform **Sweep Amplitude** and **Sweep Time** adjustments.

Main Generator Troubleshooting Hints

The interactive nature of a closed loop presents a somewhat special problem when approached from a troubleshooting standpoint. The simplest way to reduce problem complexity is to open the loop, thereby removing the interaction. The basic units of the loop can then be tested individually. The following step-by-step procedure describes how this is done. (The generator loop is all contained on the main board.)

1. Set instrument controls for 10 V p-p, 2 kHz sine-wave output.
2. Check at coaxial-wire lug of function selector switch for a 2.5 V p-p square wave. If normal, check output amplifier (Q34-Q40).
3. Unsolder and lift the end of R51 (TP7). This is the output of the integrator and input to the hysteresis switch. The generator loop has now been opened.
4. Inject a 2.5 V p-p triangle waveform into the hysteresis switch input lead (TP7).
5. Check at the coaxial-wire lug of the function selector switch for a 2.5 V p-p square wave at the injected frequency.
   a. If present, hysteresis and output switches are okay. Proceed to Step 6.
   b. If abnormal, check Q6-Q16 stages.
6. Vary frequency dial from ccw to cw while observing TP11 with a scope. Voltage at this point should remain at 0 volts throughout dial rotation. If a voltage variation is observed, check IC1 stage.
7. Vary frequency dial from ccw to cw while observing TP4. Voltage reading should vary from 0 to approximately −6 volts. If voltage does not vary, check IC2 stage and IC1 stage.
8. Vary frequency dial from ccw to cw while observing TP9. Voltage reading should remain at 0 volts. If voltage varies check IC3 stage.
9. Vary frequency dial from ccw to cw while observing TP10. Voltage should vary from 0 volts to approximately +6 volts. If voltage does not vary, check IC2 stage and IC3 stage.
10. Vary frequency dial from ccw to cw while observing TP8. Voltage reading should remain at 0 volts. If voltage varies, check IC4 and IC5 stages.
11. Re-install R51 and remove Q3 to isolate trigger circuit from integrator. If generator works properly, check Q3-Q5 stages. If abnormal, check Q1 and Q2 stages.

Sweep Generator Troubleshooting Hints

To check the sweep generator including the trigger sweep

switching circuit, use the following procedure.

1. Set instrument controls as follows:
   a. SWEEP TIME for 100 S.
   b. SWEEP WIDTH for 2.
   c. MODE at TRIG SWP.
   d. TRIG LEVEL fully ccw.
   e. Frequency dial at 0.1 mark.
2. Check transistor junctions given in the following chart for indicated states with the sweep generator in the standby condition prior to the application of a sweep trigger. If all stages are normal, either IC2 or IC3 is faulty. If an abnormal "switch state" is encountered, check *all* junctions of the transistor before deciding that is the defective stage.

Standby Condition

Stage	Q7	Q8	Q9	Q10	Q11	Q12	Q13A	Q13B
State	OFF	ON	OFF	ON	ON	OFF	ON	OFF

In some cases, it will be helpful to turn the TRIG LEVEL control quickly from fully ccw to fully cw and back to ccw, while checking transistor junctions. The following chart lists the sweep generator states immediately after triggering.

Transition Condition (Extremely Fast)

Stage	Q7	Q8	Q9	Q10	Q11	Q12	Q13A	Q13B
State	OFF	ON	OFF	OFF	OFF	ON	OFF	ON

Positive Slope Condition (Approximately 97 Seconds)

Stage	Q7	Q8	Q9	Q10	Q11	Q12	Q13A	Q13B
State	OFF	OFF	ON	OFF	OFF	OFF	OFF	ON

Negative Slope Condition (Approximately 3 Seconds)

Stage	Q7	Q8	Q9	Q10	Q11	Q12	Q13A	Q13B
State	ON	OFF	OFF	ON	OFF	OFF	ON	OFF

REMOVAL OF DUST COVERS AND PANELS

1. To gain access for calibration or maintenance, proceed as follows:
   a. Remove power cord.
   b. Loosen the two knurled captive screws on the rear panel.
   c. Pull off the rear panel.
   d. Remove the cover.
2. To gain access to any part mounted on bracket assembly behind rear panel, proceed as follows:
   a. Remove rear panel and dust cover as described in Step 1 above.
   b. Remove one heat-sink mounting screw.
   c. Remove one transformer mounting-block screw from bottom of board.
   d. Remove the two screws, lock washers, and hexnuts holding two wafers of FREQ HZ switch to bracket assembly.
   e. Remove four bracket-assembly retaining screws.
   f. Carefully pull bracket assembly to rear to obtain working room. Enough slack is available in the wiring for all normal operations.
3. To remove the front panel, proceed as follows:
   a. Remove rear panel and dust cover as described in Step 1 above.
   b. Remove all knobs, *except* frequency dial.

NOTE

Recalibration of the frequency dial is *not* required if the frequency dial is *not* removed.

   c. Unsolder BNC connections.
   d. Tag and unsolder frequency-dial potentiometer leads.
   e. Pull light bulb from indicator lens.
   f. Remove four front-panel retaining screws.
   g. Carefully pull off front panel with frequency dial/potentiometer still attached.

REPLACEMENT OF SWITCH WAFERS AND POTENTIOMETERS

1. To replace FREQ HZ switch wafer C or D or the VERNIER potentiometer, proceed as follows:
   a. Remove rear panel and dust cover as previously described.
   b. Separate bracket assembly from chassis as previously described.
   c. Tag and unsolder leads to part being replaced.
   d. Pull defective part off shaft and repair or replace with recommended replacement part.
2. To replace FREQ HZ switch wafer A or B, proceed as follows:
   a. Remove rear panel and dust cover as previously described.
   b. Remove front panel as previously described.
   c. Tag and unsolder wires to switch wafers A and B.
   d. Unsolder wafer B PC-tabs from printed circuit board.
   e. Lift switch shaft slightly to free PC-tabs, rotate switch shaft so wafers clear board parts, and pull shaft end free of rear-mounted wafers C and D.
   f. Repair or replace defective part.
3. To repair or replace function selector wafers or 20 V P-P MAX potentiometer, proceed as follows:
   a. Remove rear panel and dust cover as previously described.
   b. Loosen set screws holding potentiometer and switch knobs to inner and outer shafts and remove knobs.
   c. Tag and unsolder wires to defective part.
   d. Unsolder potentiometer PC-tabs, lift shaft slightly to free tabs, rotate switch shaft so wafers clear board parts, and pull switch/potentiometer assembly out of

front panel hole.

e. Repair or replace defective part.

REPLACEMENT OF SINE CONVERTER

1. Remove rear panel and dust cover as previously described.
2. Unsolder the five pins of sine converter A1 from top of the printed circuit board, using a solder syringe.
3. Lift assembly from bottom of the board; a thin pencil-type soldering iron can be used, if necessary, to apply temporary heat during removal.

SECTION 5
DATA PACKAGES

INTRODUCTION

This section contains data packages for the Model 134. Each data package is a quick-access document, containing maintenance data arranged for convenient viewing of the schematic diagram and all supporting data. Each data package includes a parts-location illustration; a replaceable parts list; voltage/waveform data; and a schematic diagram. Voltage and waveform data are provided on the diagrams at indicated test points as an aid to troubleshooting. Also, a list of manufacturers, a block diagram, and an outline drawing are included in this section.

ARRANGEMENT

Drawings and data packages are arranged in this section in the following order:

Title	Drawing No.
130 Series Outline Drawing	130-601
Model 134 Block Diagram	134-600
130 Series Chassis Assembly	130-000
130 Series Assembly Bracket	130-001
130 Series Main Board Data Package	130-010 and 130-210
Model 134 Sweep Board Data Package	134-011 and 134-211

LIST OF MANUFACTURERS

AmericanRadionics . . . . . American Radionics, Inc.
Danbury, Connecticut

Amp . . . . . .Amphenol Connector Division
Broadview, Illinois

ARCO . . . . . .Arco Electronics
Great Neck, L.I., New York

Boots . . . . . Boots-Townsend Aircraft
Santa Ana, California

Corn . . . . . .Corning Glass Works
Bradford, Pennsylvania

CRL . . . . . .Centralab
Division of Globe-Union
Milwaukee, Wisconsin

CTS . . . . . Chicago Telephone Systems
Los Angeles, California

Electro . . . . . Electro Cube, Inc.
San Gabriel, California

Elco . . . . . .Elco Corp.
Willow Grove, Pennsylvania

Elpac . . . . . .Elpac Incorporated
Fullerton, California

Erie . . . . . .Erie Technological Products Inc.
Erie, Pennsylvania

Fair . . . . . .Fairchild Semiconductor Corporation
Palo Alto, California

IBM . . . . . IBM Industrial Products
White Plains, New York

IMB . . . . . IMB Electronics Products
Santa Fe Springs, California

IRC . . . . . IRC Inc.
Philadelphia, Pennsylvania

Kings . . . . . .Kings Electronics Co., Inc.
Tickahoe, New York

Littelfuse . . . . . Littelfuse Inc.
Des Plaines, Illinois

Motorola . . . . . .Motorola Semiconductor Products
Phoenix, Arizona

Mura . . . . . .Mura Corp.
Great Neck, L.I., New York

RCA . . . . . RCA Semiconductor Division
Somerville, New Jersey

Richey . . . . . .Richey Electronics
Nashville, Tennessee

Semtech . . . . . Semtech Corporation
Newbury Park, California

HHSmith . . . . . .Herman H. Smith, Inc.
Brooklyn, New York

Sprague . . . . . .Sprauge Electric Company
North Adams, Massachusetts

Stack . . . . . .Stackpole Carbon Company
St. Marys, Pennsylvania

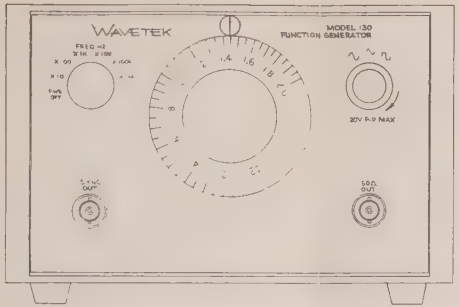
Switchcraft . . . . . .Switchcraft, Inc.
Chicago, Illinois

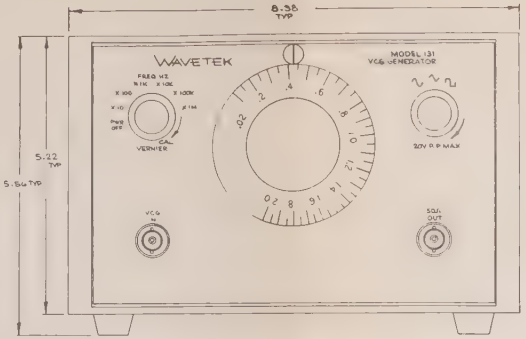
TI . . . . . Texas Instruments, Inc.
Dallas, Texas

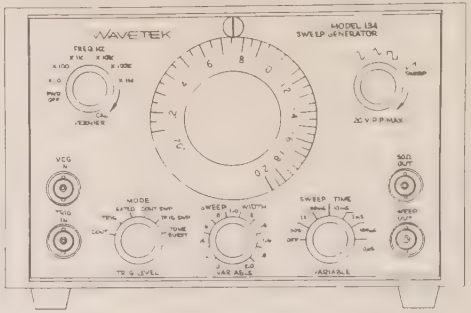
USECO . . . . . USECO Inc.
Mt. Vernon, New York

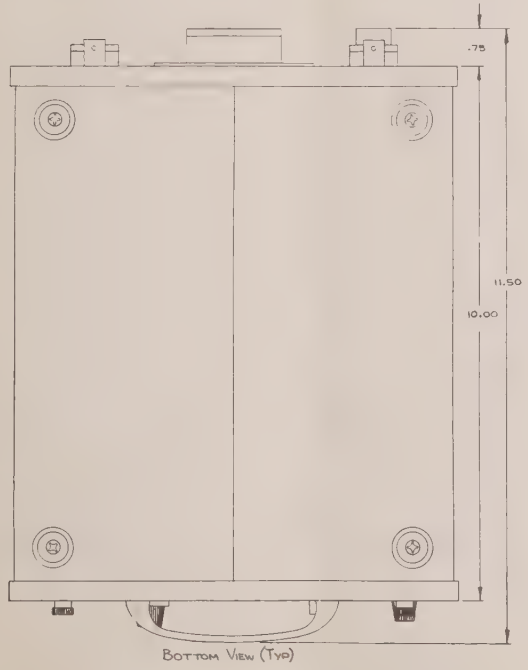
Wakefield . . . . . Wakefield Engineering, Inc.
Wakefield, Massachusetts

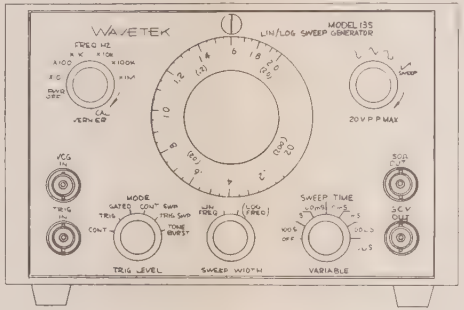
Wavetek . . . . . Wavetek
San Diego, California

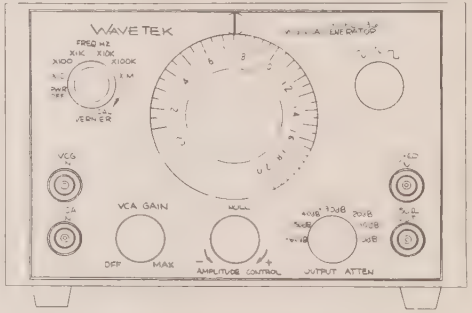


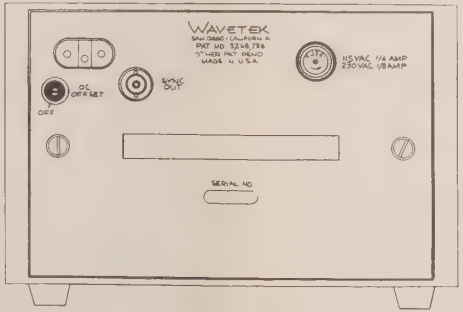












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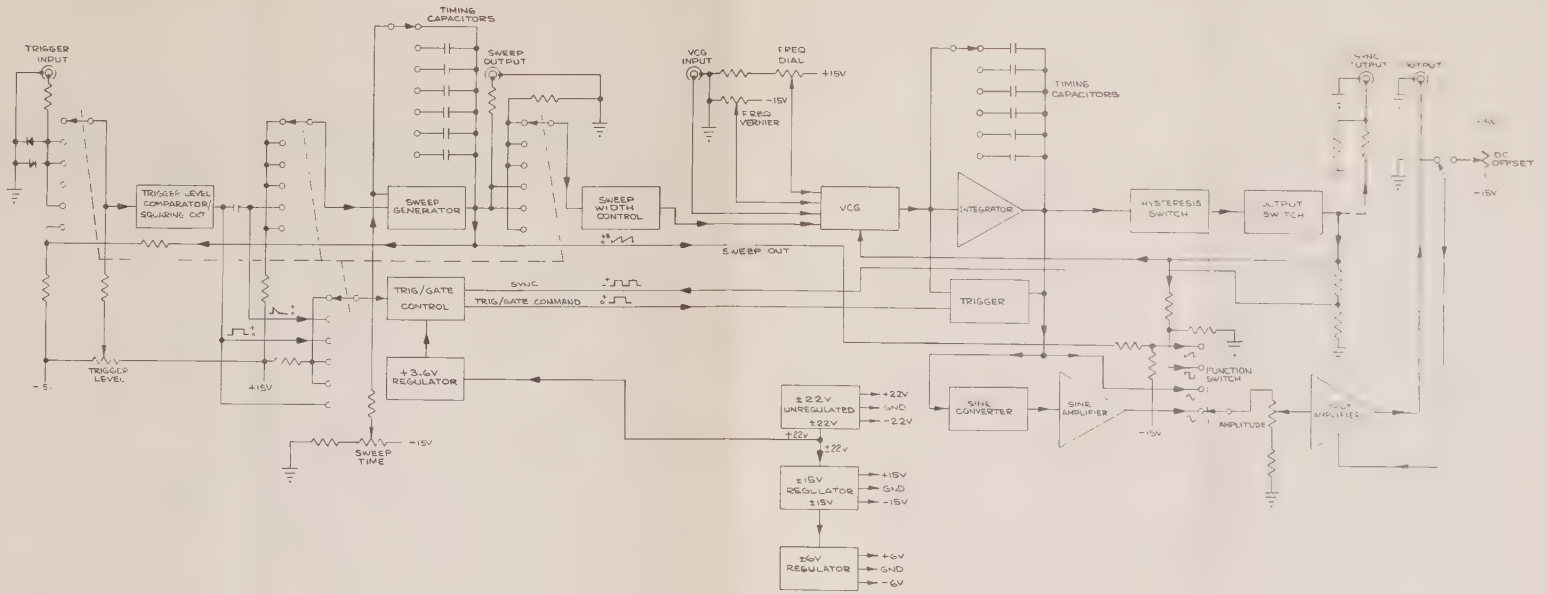
scale FULL	DR (ADAMSON)	date 7/19/69	APP		
material N/A	title OUTLINE				
	model no 130 SERIES	dwg no 130-601	rev A		
finish N/A	this document contains proprietary information and design concepts of WAVETEK and may not be used or disclosed to any person except with written permission and may not be reproduced without written permission				



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material: N/A	title: BLOCK DIAGRAM				
finish: N/A	model no: 134	dwg no: 134-600		rev: A	

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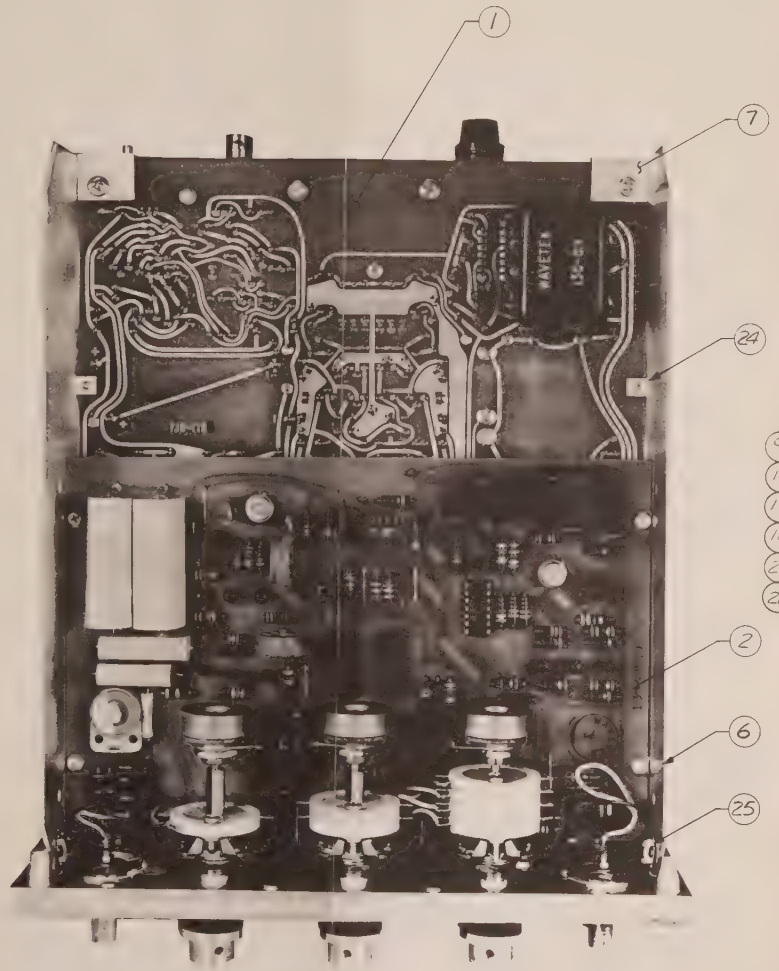

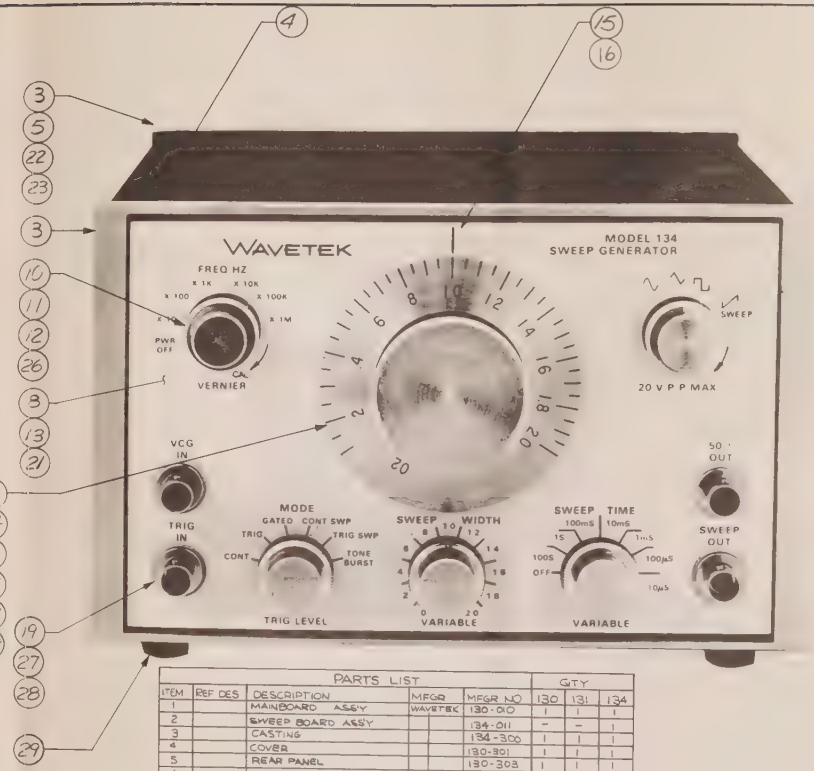

ITEM	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY 130	QTY 131	QTY 134
1		MAINBOARD ASSY	WAVETEK	130-010	1	1	1
2		SWEEP BOARD ASSY		134-011	-	-	1
3		CASTING		134-300	1	1	1
4		COVER		130-301	1	1	1
5		REAR PANEL		130-303	1	1	1
6		SIDE PLATE		130-304	2	2	2
7		MOUNTING BLOCK		130-305	2	2	2
8		FRONT PANEL (130)		130-307-1	1	-	-
9		DIAL KNOB		130-320	1	1	1
10		CO-AXIAL KNOB		130-321	1	2	5
11		STANDARD KNOB		130-322	1	-	-
12		SMALL KNOB		130-323	1	2	5
13		FRONT PANEL (134)		134-302	-	-	1
14		DIAL		012-001-2	1	1	1
15		INDICATOR LENS		141-317	1	1	1
16		RETAINER	TRUARC	5305-31	1	1	1
17	R1	POT 5K	A/B	JA1G52P5K2UA		1	1
18	R175	POT, MODIFIED 1K	WAVETEK	130-315	1		
19	J2,J4,J5,J6	BNC CONNECTOR	KING	KC7946	2	2	4
20		POWER CORD	BELDEN	17858-5	1	1	1
21		FRONT PANEL (131)	WAVETEK	130-307-2	-	1	-
22		HANDLE	QUALITY	1162	1	1	1
23		CAP SCREW	DEUTSCH	7900-10-8-2	2	2	2
24		CHASSIS FASTENER	USECO	19918	4	4	8
25		CLIP NUT	SHUR-LOK	SL210-06-2	4	4	4
26		BUSHING	THOMPSON	4L2FF	2	2	5
27		SHOULDER WASHER	SMITH	2668	6	4	8
28		SOLDER LUG	SMITH	1497	3	2	4
29		FOOT	BUDWIG	F69	4	4	4
30							
31		CASTING MODIFICATION	WAVETEK	130-313-1	-	1	1
32		CASTING MODIFICATION	WAVETEK	130-313-2	1	-	-

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rev	ecn	by	date

tolerance unless otherwise specified: XXX ± 010, XX ± 030
scale N/A
material N/A
finish N/A
by TECHNO date 8-1-69

WAVETEK SAN DIEGO, CALIF.

title: CHASSIS ASSY

model no 130-134 | dwg no 130-000 | rev A

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PARTS LIST

ITEM	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY	
1		BRACKET	WAVETEK	130-302	1	
2	T1	*TRANSFORMER		90-500	1	
3		TRANSFORMER BRACKET		130-306	1	
4		STANDOFF (MODEL 130 ONLY)	MH SMITH	2362	2	
5	F1	FUSE 1/8 AMP 3SV	LITTELFUSE	313.250	1	FOR 115V MODEL
6		FUSE HOLDER		342012	1	
7		FUSE 1/8 AMP 230V		313.125		FOR 230V MODEL
8	1	POWER RECEPTACLE	SWITCHCRAFT	AC3-G	1	
9	R76	RESISTOR 1/2W 10% CARBON 2.8K	STACKPOLE	RC20GF282K		MODEL 136 ONLY
10						
11	R172, SW4	DC OFFSET SWITCH 10K POT	CTS	UL5186	1	
12	SW2	115-230V SWITCH	SWITCHCRAFT	46256LF	1	
13						
14						
15						
16	J3	BNC CONNECTOR	KING	KC7946	1	
17		SHOULDER WASHER	SMITH	2668	3	
18						
19		FASTENERS #6-32	BOOTS SCREW	TB1D070	4	
20		SOLDER LUG	H H SMITH	1414-4	2	
21		SOLDER LUG		499	1	
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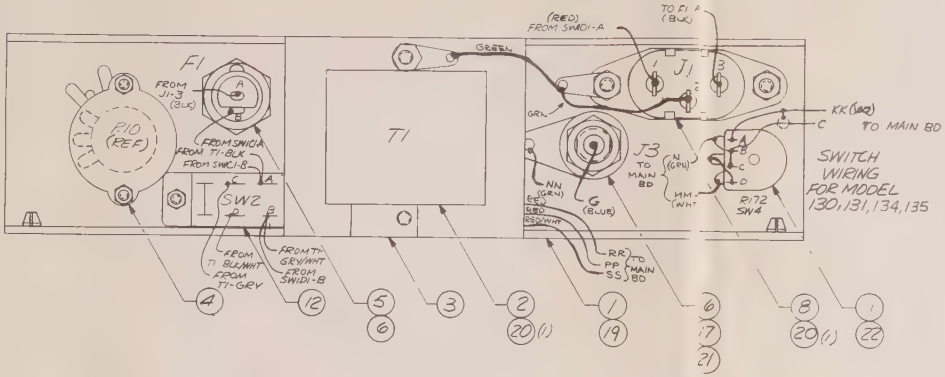

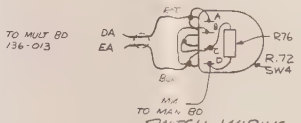

	A	ECN 283	BS	11-8-68	WD
tolerance unless otherwise specified	rev		by	date	app'd
XXX ± .010 XX ± .030	WAVETEK				
X° N/A	drawn BK, MK, HK	date 7-21-69	app'd		
material N/A	title ASSY, BRACKET				
finish N/A	model no. 130-136	dwg no. 130-001	rev A		

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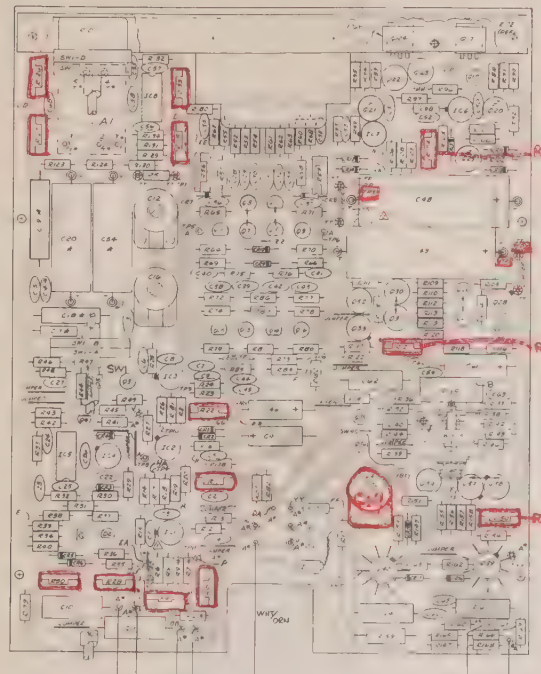
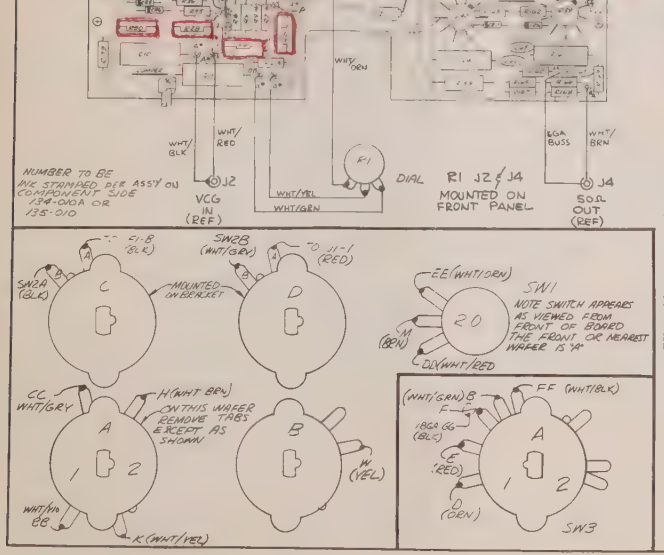


NUMBER TO BE INK STAMPED PER ASS'Y ON COMPONENT SIDE 134-00A OR 135-00



PARTS LIST

ITEM	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
1	C14	SILVER MICA 500V 5% 56PF	RCD	DM15-560J	1
2	C3	68PF		680J	1
3	C28 C33	30PF		30J	2
4	C29 C32	300PF		301J	2
5	C30,C31	56PF		56J	2
6	C15	.5 9 0PF		911J	1
7	C5 C22	CERAMIC DISC 1000V 22PF	CRL	DD-100	2
8	C55 C56 C5226	22PF		DD-220	4
9	C38 C43	33PF		DD-330	2
10	39 42	47PF		DD 470	2
11	27	100PF		DD-101	1
12	C47 C48	150PF		DD-151	2
13	C63	470PF		DD-471	1
14	40, 41	680PF		DD-681	2
15	C36 C50 C51	220PF		DD-221	4
16	C46 C52 C53	50V .005uF		DD 502	4
17	C65, C66	50V .01uF		CK-103	2
18	C2 C4 C7 C9 C25 C26 C34 - C37 C44 C45 C57 C58 C61 C62	20V .1uF		UK20-04	6
19	C7	POLYSTYRENE 100V 1% .01uF		PAZB 03F	1
20	C18	.1uF		PAZB 10AF	1
21	C19	MYLAR 200V 1% .1uF	ERO SIEMENS AMERICAN	210-ERC-105F	1
22	C2 C54	M. 10% 5uF		WYTK-2MPW	2
23	C10, C11 C46 C47 C61 C62	ELECTROLYTIC .16V 100uF	SPRAGUE	5000H1616DC7	6
24	C48 C49	35V 1000uF		34-730-1000 35T	2
25	C12 C64 C64	VARIABLE 4.5-25PF		503 001 37A	3
26					
27					
28					
29					
30					
31	CR1-CR10, CR15-CR18	DIODE FD0666	FAIRCHILD	FD0666	14
32	CR11-CR14	SCE-.	SCE TECH	SCE 1	4
33					
34					
35					
36					
37					
38	Q2	M CIFIED PER 130-316		TIP29	1
39	Q24	M CIFIED PER 3C 316		TIP30	1
40	Q23 Q40	2N2905	FAIRCHILD	2N2905	2
41	Q28 Q39	2N3249		2N3249	2
42	Q3	2N3563		2N3563	1
43	Q4 Q5 Q6 Q14 Q15	MPS 3640	MOT ROA	MPS 3640	5
44	Q1 Q2 Q3 Q6 Q8 Q9 Q29 Q30 Q36	2N3646	FAIRCHILD	2N3646	8
45	Q22 Q23 Q32	2N3638		2N3638	3
46	Q20 Q21 Q25	(REVISED) 2N3638(A2)		2N3638	5
47	Q11	2N3903	MOTOROLA	2N3903	1
48	Q12	2N3905		2N3705	1
49	Q34	TDI01	SPRAGUE	TDI01	1
50	Q37, Q38	MATCHED PAIRS (-8)	FAIRCHILD	2N2908	2
51	Q10, Q11	(-10)	MOTOROLA	MPS 8840	2
52	Q7 Q8 Q26 Q27	(-11)	FAIRCHILD	2N3646	4
53	Q30 Q31	(-9)		2N3638	2
54					
55					
56					
61					
62					

⚠ MODEL 134 ONLY
⚠ MODEL 135 ONLY
⚠
⚠
⚠
6
7
8 # INDICATES AMP PIN INSTALLED ON CIRCUIT SIDE
9 T " TERMINAL " " "
10 ☆ INDICATES MATCHED SET
11 ⟷ INDICATES MATCHED PAIR
12 Z INDICATES ZENER
13 # INDICATES SELECTED VALUE - NOMINAL VALUE AS SHOWN

PARTS LIST

ITEM	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
63	IC1 3	LINEAR IC (-13)	FAIRCHILD	uA709C	3
64	IC5	(-5)	RCA	CA3030	1
65	IC4	(-17)		CA3036	1
66	IC2	(-18)		CA3039	1
67	IC8	(-16)		CA3080	1
68	IC6, IC7	(-14)	FAIRCHILD	uA709C	2
69					
70					
71					
72	R56 R59	POTENTIOMETER 100Ω	CRL	BA1603-101	2
73	R26 R27	250Ω		-021	2
74	R24 R2 R33	500Ω		-502	3
75	R35	1K	CTS	W 30 SWZ ASST	1
76	R104	1K	CRL	BA1603-103	1
77	R28 R1 R22 R28 R60 R38 R83	100K		-813	7
78	R6	10K	CTS	SWI-RA	1
79					
80					
81					
82					
83	R15 R34 R162 R43	ARB IN 1/2W 5% 47Ω	STACKPOLE	RC20GF470K	4
84	R45 R48 R35 R76	6.9Ω		6R8K	3
85	R53 R87	10Ω		00K	2
86	R38	27Ω		270K	1
87	R R2463 R4C R	47Ω		470K	5
88	R41	68Ω		68K	1
89	R57 R58 R74 R80	220Ω		22K	4
90	R116 R117	10% 330Ω		33K	2
91	R52 R43	5% 330Ω		33K	2
92	R65, R71 R9, R14	10% 470Ω		47K	4
93	R32 R33 R132 R34	560Ω		56K	4
94	R100	680Ω		68K	1
95	R30 R75 R70 R88 R40	K		02K	5
96	R5 R25 R28 R18	5K		52K	4
97	R42 R80	22K		222K	5
98	R102 R5 R103 R78	27K		272K	4
99	R13 R82 R101	39K		392K	3
100	R88 R89 R92 R93 R96 R97 R107	47K		472K	7
101	R45 R53 R62	5% 62K		622J	3
102	R44	10% 68K		682K	1
103	R46-R48 R78	10K		103K	4
104	R43	3K		183J	1
105	R14 R15	8K		83K	3
106	R3 R54 R61	27K		273K	3
107	R20	9K		9 3J	1
108	R179	50K		04K	1
109	R6	220K		224K	1
110	R146	270K		274K	1
111	R143	560K		564K	1
112	R29	820K		824K	1
113	R39	N/A		05K	1
114	R9	5% 2MΩ		25J	1
115	R49	820K		824K	1
116	R23	2.9MΩ		29J	1
117	R12	4.7MΩ		475K	1
118	R7	6.8MΩ		685K	1
119	R182	750Ω		751	1
120					
121					
122					
123	R101 R102	CARBON 2W 5% 47Ω	STACKPOLE	RC42GF470K	2
124	R59	METAL FILM 1W 1%	IRC	MEL RN70D	1
125					
126		MATCHED RESISTORS			
127	R109 R110	METAL FILM 1W 1% 2.49K Ω	CORNING	RN60D	2
128	R118 R119	4.22K Ω			2
129	R103 R106 R108 R111	10K (-4)			4

PARTS LIST

ITEM	REF DES	DESCRIPTION	MFGR	MFGR NO	QTY
30	R134 R140	METAL FILM 1/4W 1% 215Ω	CRL	NO	1
31	R35-R58	10Ω			1
32	RZ	42.2Ω			1
33	R51 R163 R96, R 67 R162	49.9Ω			4
34	R54	8.25Ω			1
35	R81 R23	82.5Ω			2
36	R24	50Ω			1
37	R74 R78 R141 R51	249Ω			4
38	R55 R60 R137 R142	49.9Ω			4
39	R170	825Ω			1
40	R32 R77	499Ω			2
41	R84	3.01Ω			1
42	R85	249Ω			1
43	R30	4.99Ω			1
44	R143 R53	78Ω			2
45	R100	2.81K			1
46	R64 R70	3.32K			2
47	R160, R122	3.83K			2
48					
49	R66 R69	4.75K			2
50	R2064 PTH	4.99K			1
51	R4 R2 R8 R29 R71 R81	MATCHED SET 6.49K-3			6
52	R4 INSTALLED	6.98K			1
53	R102 R3	3.65K			2
54	R52	8.87K			1
55	R5	5K			1
56					
57					
58					
59					
60	SA1	SWITCH WAFER	WAVETEK	30-SW1	1
61	SW A	WAFER	CTS	30-SW2	1
62	SW1 B		WAVETEK	30-SW2	1
63	SW3	SWITCH		130-SW2	1
64					
65		TRANSISTOR SOCKET	E-Z-	39-0	1
66		HEATSINK	WAKEFIELD	NF 227	1
67		TRANSIPAD	M R SIL	2121	1
68					
69	J1 A	AMP J1	AMP	6 83	1
70	- -	TERMINAL	- E	- B	1
71	TP		- E	- B	1
72		SOLDER LUG	SMITH	440	1
73					
74	A1	SINE MODULE	WAVETEK	31-011	1
75		BRACKET ASSY		130-00	1
76		HEATSINK		130-911	1
77	I1	LAMP	MURA	L28/30	1
78		CIRCUIT BD	WAVETEK	130-110F	1
79					
80					
81					
82					
83					
84					
85					
86					
87					
88					
89		SUPPORT BLOCK		00 555	1

B	284		
A	233	B-	

WAVETEK

ASSY MAIN BD

SCALE N/A	DRAWN BY BOUCHER 24 69
SIZE N/A	MODEL 134-00 135-00

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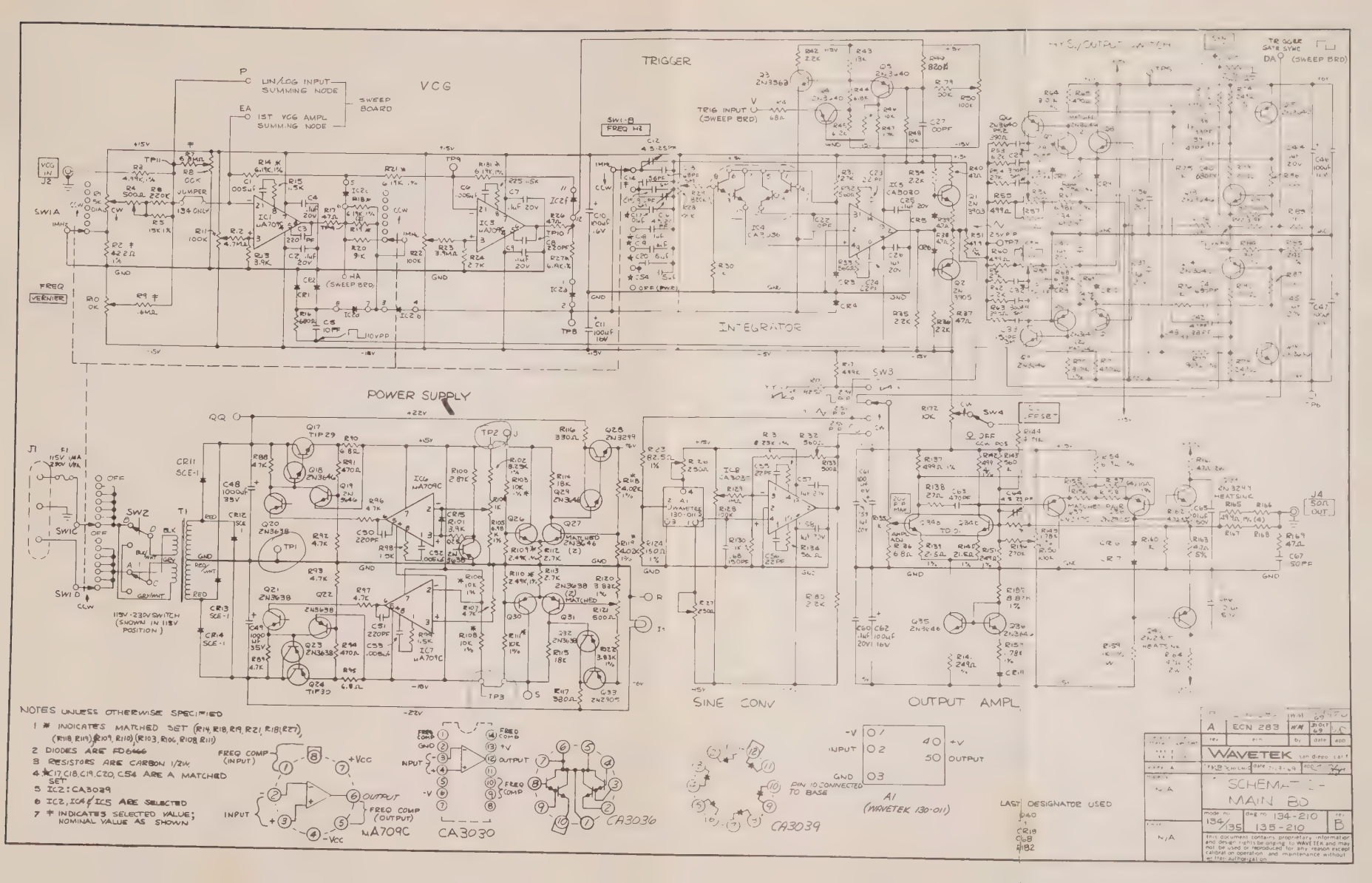
VCG
TRIGGER
INTEGRATOR
POWER SUPPLY
SINE CONV
OUTPUT AMPL
SW/OUTPUT SWITCH
SCHEMATIC - MAIN BD
WAVETEK
NOTES UNLESS OTHERWISE SPECIFIED
1 * INDICATES MATCHED SET (R14, R18, R19, R21, R181(R22), (R118, R119), (R109, R110), (R103, R106, R108, R111)
2 DIODES ARE FD6466
3 RESISTORS ARE CARBON 1/2W
4 C17, C18, C19, C20, C54 ARE A MATCHED SET
5 IC2: CA3089
6 IC2, IC4 & IC5 ARE SELECTED
7 # INDICATES SELECTED VALUE; NOMINAL VALUE AS SHOWN
uA709C
CA3030
CA3039
CA3036
A1 (WAVETEK 130-011)
PIN 10 CONNECTED TO BASE
LAST DESIGNATOR USED
C40
CR18
CU8
R182
ECN 283
SCHEMATIC - MAIN BD
model no. 134/135
dwg no. 134-210
rev. B
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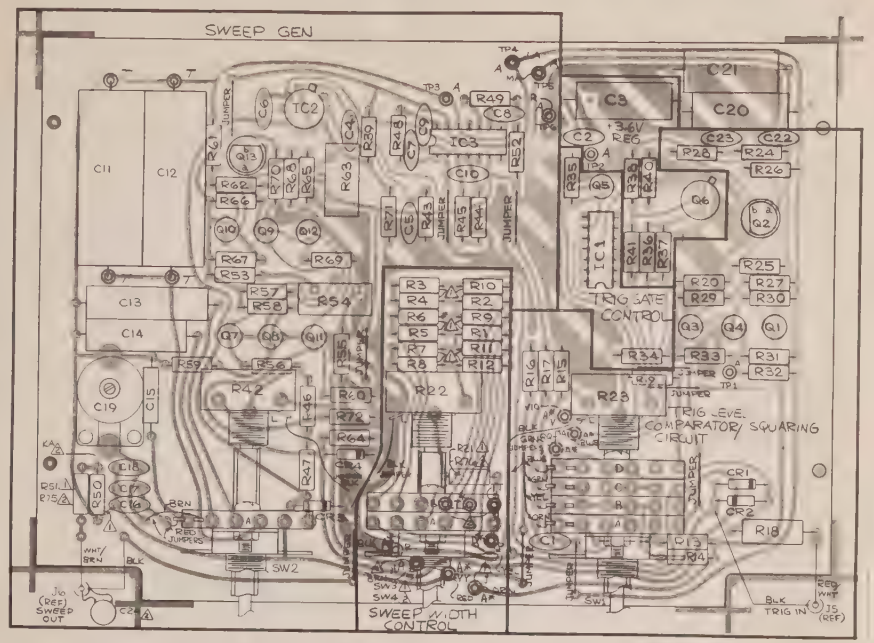
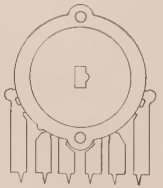


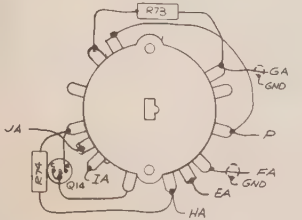
NOTES:-

SW3 ⚠1 SW4 ⚠2

1. JUMPERS, FROM BOARD TO SWITCHES, BNC'S & LUGS ARE STRANDED INSULATED WIRE.
2. LETTERS YY, DA, VQQ, P, HA, EA, J, R, F, S ARE CONNECTIONS TO THE MAIN BOARD.
3. T - INDICATES TERMINALS MOUNTED ON COMPONENT SIDE.
4. A - INDICATES AMP PIN ON COMPONENT SIDE.
5. A✱ - INDICATES AMP PIN ON CIRCUIT SIDE.
6. ⚠1 INDICATES MODEL 134 ONLY
7. ⚠2 INDICATES MODEL 135 ONLY
8. T INDICATES TERMINAL (USECO 2010B-1) INSTALLED ON CIRCUIT SIDE
9. LETTERS FA, GA, JA, LA, MA, R, IA/KA ARE CONNECTIONS TO LOG CONVERTER 8D



IN CCW POSITION, ROTOR POSITION IS TYP ON ALL SWITCHES AS VIEWED FROM KNOB END OF SWITCH.



135-SW4-B

PARTS LIST

ITEM	REF DES	DESCRIPTION	MFG BY	MFG No	QTY 134	QTY 135
		CAPACITORS				
1	C6, C6, C7, C8	33pf CERAMIC DISC, 1000V	CRL	DD330	4	4
2	C16	68pf 5% SILVER MICA	ARCO	DM15-680J	1	1
3	C18	82pf 5% SILVER MICA	ARCO	DM15-820J	1	1
4	C1	100pf 5% SILVER MICA	ARCO	DM15-101J	1	1
5	C17	910pf 1% SILVER MICA	ARCO	DM15-911J	1	1
6	C15	.01 μfd, 1%, 100V	IMB	PA2B103F	1	1
7	C2 C5, C9, C10 C22, C23	.1 μfd CERAMIC DISC 20V	CRL	UK20-104	6	6
8	C14	.1 μfd 1% 100V	IMB	PA2B104F	1	1
9	C13	1.0 μfd 1% 200V	ELECTRO CUBE	2108C1105F	1	1
10	C11, C12	5.0 μfd 10% 200V MATCHED SET	AMERICAN RADIONIC	WVTY 2MFW	2	2
11	C3, C20, C21	100 μfd 20V (ELECTROLYTIC)	RICHEY	M-375-100-20F	3	3
12	C19	4.5- 25 pf (VARIABLE)	ERIE	503-001, A	1	1
13	C24	.0022μF CERAMIC DISC 1000V	CRL	DD-222	—	1
14						
15						
		INTEGRATED CIRCUITS				
16	IC3	LINEAR IC	RCA	CA3030	1	1
17	IC2		RCA	CA3036	1	1
18	IC1	MRTL	MOTOROLA	MC 5516P	1	1
		DIODES				
19	CR1, CR2, CR3, CR4,	FDG666	FAIRCHILD	FDG666	4	4
		TRANSISTORS				
20	Q6	2N3299	FAIRCHILD	2N3299	1	1
21	Q7, Q8, Q11	MPS3640	MOTOROLA	MPS3640	3	3
22	Q1,Q3,Q4,Q5 Q9, Q10 Q12, Q14	2N3646	FAIRCHILD	2N3646	7	8
23	Q2, Q13	TD101	SPRAGUE	TD101	2	2
24						
		MISCELLANEOUS				
25						
26	SW3A	SWITCH WAFER	WAVETEK	134-SW1-1	1	—
27	SW3B SW4A	SWITCH WAFER	WAVETEK	184-SW1-2	1	1
28	SW2A SW3A SW3B SW4B	SWITCH WAFER	WAVETEK	130-SW1-2	5	5
29	L	GROUND LUG	H.H. SMITH	1497	3	3
30	T	TERMINAL	USECO	2010B-1	4	7
31	A A✱	AMP PIN	AMP	60599-1	14	12
32		PIRCUIT BD (DRILL 134-510)	WAVETEK	134-111B	1	1
33	SW1	MODIFIED 134-SW1 DETENT		134-304-1	1	1
34	SW2	MODIFIED 134-SW1 DETENT		134-304-2	1	1
35	SW3	MODIFIED 134-SW1 DETENT		134-304-3	1	—
36	SW4	MODIFIED 134-SW1 DETENT		135 304-4	—	1
37	SW4 B	T108	CTS	T108	—	1
38						
39						

PARTS LIST

ITEM	REF DES	DESCRIPTION	MFG BY	MFG NO	QTY 134	QTY 135
		POTENTIOMETERS				
40	R54	500Ω	CRL	BA1601-B02	1	1
41	R63	1K	CRL	1-B03	1	1
42	R22, R23, R42	10K	WAVETEK	134 R1	3	3
43						
44						
45						
		RESISTORS - CARBON - 1/2W 10%				
46	R48 R49	150Ω	STACKPOLE	RC20GF 151K	2	2
47	R69	330Ω		-331K	1	1
48	R60	680Ω		-681K	1	1
49	R29, R32, R35 R48, R70	1K		-102K	5	5
50	R36, R37	1.2K		-122K	2	2
51	R34, R71	1.8K		-182K	2	2
52	R26, 33, 41, 52	2.2K		-222K	4	4
53	R27, 28, 30, R66, 67, 68	3.3K		332K	7	7
54	R15, R38	4.7K		-472K	2	2
55	R30	5.6K		-562K	1	
56	R24	6.8K		-682K	1	
57	R13, 14, 20, 57	10K		-103K	4	4
58	R39	22K		223K	1	
59	R25 R64	47K		473K	2	2
60	R44 R45	150K		154K	2	2
61	R56	220K		224K	1	1
62	R 8	OK, 1W, 10%, CARBON		RC32GF 109K	1	1
63						
		RESISTORS - METAL FILM 1/4W, 1%				
64	R55, R59	909Ω	CORNING	RN60D	2	2
65	R16	2.49K			1	1
66	R61	3.01K			1	1
67	R62	8.25K			1	1
68	R10, 53, 58	12.1K			3	3
69	R17	15K			1	
70	R1, R2, R4 R5, R8, R12	24.9K			6	—
71	R46	30.1K			1	1
72	R21	46.4K			1	—
73	R3, R6, R7 R9, R10, R11	49.9K			6	—
74	R47	237K			1	1
75	R76	4.99K			—	2
76	R74	5.76K			—	1
77	R75	620Ω CARBON 1/2W 5%	STACKPOLE	RC20GF620J	—	1
78	R72	68Ω CARBON 1/2W 5%	STACKPOLE	RC20GF 680J	1	1
79	R50, R51	300Ω CARBON 1/2W 5%	STACKPOLE	RC20GF 301J	2	—
80	R43	240K CARBON 1/2W 5%	STACKPOLE	RC20GF 244J	1	1

	A	283	BD	11/14	⚠1
tolerance unless otherwise specified	rev	ecn	by	date	appd
XXX ± .010 XX ± .030	WAVETEK San Diego, Calif.				
scale 2X	dr'n L. ADAMSON	date 9/23/69	appd		
material NOTED	title SWEEP BOARD				
finish NONE	model no 134 135	dwg no 134-011 135-011	rev A		

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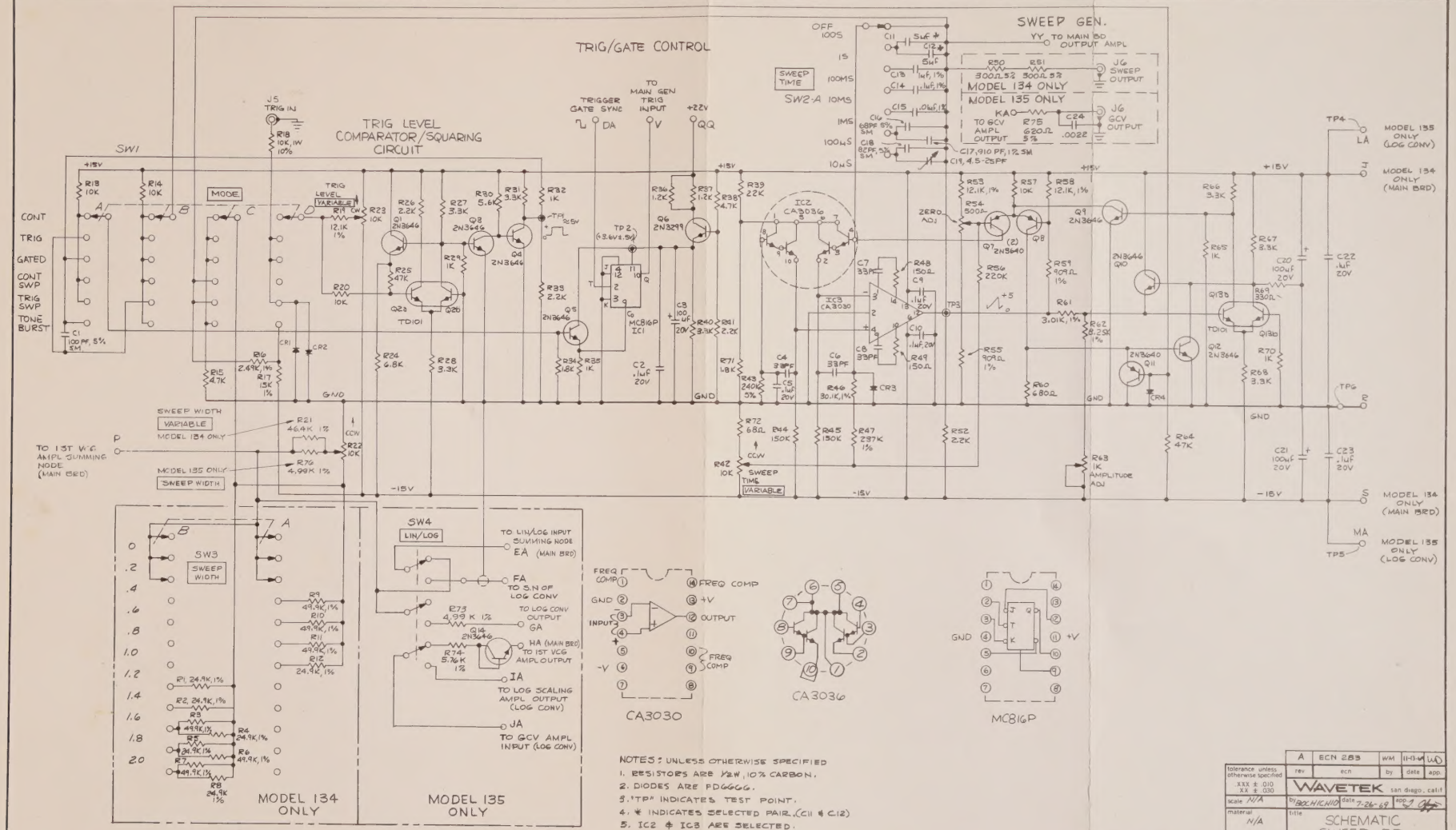

NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE ½W, 10% CARBON.
2. DIODES ARE FDG666.
3. "TP" INDICATES TEST POINT.
4. * INDICATES SELECTED PAIR. (C11 & C12)
5. IC2 & IC3 ARE SELECTED.

LAST COMPONENT DES.
R76
C24
CR4
IC3
Q14

rev	ecn	by	date	app.
A	ECN 283	WM	11-13-69	WM

tolerance unless otherwise specified: .XXX ± .010, .XX ± .030
scale: N/A
material: N/A
finish: N/A

WAVETEK san diego, calif
by: BOCHICHIO date: 7-26-69 app: [signature]
title: SCHEMATIC SWEEP BD
model no.: 134/135 dwg no.: 135-211 rev.: A

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